ROYAL AERO CLUB OF W.A.

AND

HAWKVIEW HOLDINGS PTY. LTD.

MURRAYFIELD AIRPARK AND RESORT COMPLEX

CONSULTATIVE ENVIRONMENTAL REVIEW

ALAN TINGAY & ASSOCIATES

NOVEMBER 1991

REPORT NO: 91/17

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AN INVITATION TO COMMENT ON THIS CER

The Environmental Protection Authority (EPA) invites people to make a submission on this Consultative Environmental Review

The Royal Aero Club of WA (Inc) have proposed the development of an airpark and resort complex on Lots 11 and 12 Nambeelup Road, Nambeelup, within the Shire of Murray. In accordance with the Environmental Protection Act 1986, a Consultative Environmental Report (CER) has been prepared which describes these proposals and their likely effects on the environment. The CER is available for public review for 4 weeks from 25 November 1991 and finishing on 23 December 1991.

Comments from Government Agencies and from the public will assist the EPA to prepare an Assessment Report in which it will make a recommendation to Government.

Why write a submission?

A submission is a way to provide information, express your opinion and put forward your suggested course of action - including any alternative approach. It is useful if you indicate any suggestions you have to improve the proposal.

All submissions received by the EPA will be acknowledged. Submissions will be treated as public documents unless confidentiality is requested, and may be quoted either in full or in part in each report.

Why not join a group?

If you prefer not to write your own comments, it may be worthwhile joining with a group or other groups interested in making a submission on similar issues. Joint submissions may help to reduce the workload for an individual or group, as well as increase the pool of ideas and information. If you form a small group (up to 10 people) please indicate all the names of the participants. If your group is larger, please indicate how many people your submission represents.

Developing a submission

You may agree or disagree with, or comment on, the general issues discussed in the CER or the specific proposals. It helps if you give reasons for your conclusions, supported by relevant data. You may make an important contribution by suggesting ways to make the proposal environmentally more acceptable.

When making comments on specific proposals in the CER:

- clearly state your point of view;
- indicate the source of your information or argument if this is applicable; and
- suggest recommendations, safeguards or alternatives.

Points to keep in mind

By keeping the following points in mind, you will make it easier for your submission to be analysed:

- attempt to list points so that the issues raised are clear. A summary of your submission is helpful;
- refer each point to the appropriate section, chapter or recommendation in the CER;
- if you discuss different sections of the EMP, keep them distinct and separate, so there is no confusion as to which section you are considering;
- attach any factual information you wish to provide and give details of the source. Make sure your information is accurate.

Remember to include:

- your name;
- address; and
- date.

The closing date for submissions is:

23 December 1991

Submissions should be addressed to:

The Chairman,
Environmental Protection Authority
1 Mount Street
PERTH WA 6000

Attention: Ms J Boyer

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SUMMARY

1. Introduction

The Murrayfield Airpark and Resort Complex is an initiative of the Royal Aero Club of W.A. and Hawkview Holdings Pty. Ltd which share the role of proponent. This joint arrangement reflects the ownership of the land to be developed. The objective of the project is to create a facility within the Murray-Mandurah area that will service the needs of flyers. This Consultative Environmental Review (CER) describes the proposed Murrayfield Airpark in detail.

2. The Development

The aerodrome will provide general aviation facilities that are able to handle aircraft with a maximum take-off weight of up to 5,700kg. This equates to single and twin engine propeller driven aircraft with a maximum capacity of about twelve people. There will be two sealed runways that will be usable in both directions, one oriented in a north-east, south-west direction (No. 1) and the second in a east-west direction (No. 2). There will also be a grassed runway which will parallel runway No. 1. Provision has been made in the layout of the aerodrome for a Heliport and associated facilities such as hangers, service areas and offices.

It is proposed that a resort resort facility designed to provide accommodation and recreational facilities for a total of 370 people will be built adjacent to the aerodrome. The resort building will also provide convention facilities, restaurants and indoor sporting facilities and a golf course with of 9 holes set in surrounds containing natural and artificial wetlands.

3. The Existing Environment

Physical

The development site is generally low lying and contains a number of broad poorly drained areas, wetlands and poorly defined ephemeral stream courses. Rains which fall on the site move through the permeable dunal sands and into the underlying aquifer. Groundwaters then flow toward low-lying areas, discharging to wetlands and drainage courses. In summer the water table drops and wetlands and winter-wet areas dry out. The Murrayfield Airpark is within the catchment of the Serpentine River which flows into the Peel Inlet via Lake Goegrup. Ultimately all waters which drain from the site find their way into Nambeelup Brook and then into the Serpentine River.

The site contains deep, grey, quartz Bassendean Sands. These are mostly bleached, permeable and well drained. They have a low nutrient availability which stems from the soils inability to retain nutrients. Consequently Bassendean Sands can be expected to have low to very low phosphorus retention indices. This is important when considering the environmental implication of the application of nutrients to the site in the form of fertilisers and from effluent disposal systems.

There are two water-bearing formations that are capable of supplying water to the development. These are the Bassendean Sand which is the uppermost unconfined aquifer and the Leederville Formation which underlies the Bassendean Sand. Water from both are essentially fresh with low salinity levels.

Vegetation

Vegetation on the Murrayfield site belongs to the Central and South Bassendean Complex. These vegetation complexes are common on the Swan Coastal Plain extending from Gnangara in the north to just south of Bunbury. The upland vegetations consist of two types, Banksia Woodland and Jarrah Woodland. The Jarrah Woodlands have all been heavily disturbed and no good stands remain. Two main areas of Banksia Woodland remain which are in relatively good condition.

The vegetation of the lowland areas is determined by the degree of inundation. Much of the lowland vegetation consists of a *Kunzea ericifolia* Scrub or Thicket and where the watertable is close to the surface in winter, wetland indicator species such as *Juncus pallidus*. Much of the area containing *Juncus pallidus* has been intensively grazed. Sites with surface water for longer periods during winter and spring are characterised by *Melaleuca rhaphiophylla* Woodland. The best example of a Paperbark Swamp is in the north-eastern section of the property.

Fauna

A desk study was carried out to assess whether any rare and endangered species of fauna could possibly inhabit the site. It was concluded that this is unlikely given the general absence of such species in the region and the large degree of clearing over the site.

Social Environment

In 1986, the estimated resident population of the Peel Region was 29,672. The Town of Mandurah, contained the greater proportion of this population (19,196 people). Population projections for the region indicate that regional population could increase to a figure between 65,000 and 70,000 by year 2001, and to a figure between 83,000 and 90,000 by year 2011.

At June 1990, it was estimated that the unemployment rate for the Peel Region stood at 10.4% for the total urban force of 17,427, with Mandurah at 12.8%, significantly higher. This compares with the State unemployment rate of 7.6%. Analysis of unemployment figures show that employment opportunities for persons in the age groups between 15 and 30 years, will be needed.

The Peel region is one of the State's most popular tourist destinations. Total arrivals for accommodation purposes increased by 50% between 1983 and 1987 and increased opportunities for growth in visitor and leisure activities have been identified as important to the District and Regional economy.

Land Use

The site is currently used for cattle grazing with cattle feeding on introduced pasture species and the regrowth of native vegetation. A single runway together with support facilities such as hangers and clubrooms have been constructed on Lot 11.

The majority of land surrounding the development property is agricultural and is used to raise cattle or grow fodder crops. Land on the western border has been subdivided into 2ha lots for use as dog kennels. An abattoir, which at the time of writing was not in operation, is located near the south east corner of the site and a large commercial piggery occupies neighbouring land to the north.

Existing Noise Levels

The level of noise generated by activities associated with neighbouring land use activities was measured as part of a noise assessment performed on the site. The adjacent kennel zones and piggery have the potential to generate noise that could annoy users of the resort. However, measurements taken on the site did not detect noise coming from either of these sources.

4. Assessment of Environmental Impacts

General

The proponent has endeavoured to minimise the potential environmental impacts posed by the project by taking into account the natural features of the site and the constraints that apply to development within the catchment of the Peel-Harvey Estuary. Regard has been given to the sociological impacts that could affect nearby residents as a result of the operation of the aerodrome. Impacts relating to noise, nutrients, vegetation and wetlands were identified as having the potential to be significant.

Noise

A study on the acoustic impact of the development found that unacceptable noise levels would be generated by fixed-wing aircraft over some residential lots immediately to the west of the existing runway which runs east-west. This is an existing situation as at present the east-west runway in the only operational runway and thus is used by all air traffic. The study concluded that if a policy of preferential use of the new runway were to be activated then the noise currently experienced to the west of the existing runway would be substantially reduced. All other areas that would be affected by noise generated by fixed wing aircraft are non residential or within the development itself and thus do not present a problem.

Nutrients

As the development site is within the catchment of the Peel-Harvey Estuary there is concern relating to the quantity of nutrients applied to the site. There will be a net reduction (about 65%) in the amount of nutrients applied to the site as a result of the

development proceeding. This is mainly because of the reduced application of fertilisers over the site as a result of the change in land use away from agriculture. It is proposed that nutrients applied to the site as a result of treated effluent disposal and fertiliser application will be managed to minimise nutrient export off-site or into any wetlands. Management will include, the minimisation of fertiliser application, soil ammendment in areas where nutrients would be applied, no discarge of effluents or surface drainage into wetlands or water courses, and the monitoring of wetland, groundwater, and soil nutrient levels.

Vegetation

The layout of the aerodrome and the resort has been designed to retain as much quality vegetation as possible. As a result the only areas of vegetation that will be impacted upon are considered to be of insignificant scale or are significantly degraded. Extensive plantings of selected indigenous species of plants especially around the perimeter of the site and throughout the golfcourse will compensate for the cleared area.

Wetlands

A priority in the layout of the proposed development has been the avoidance of wetlands wherever possible. Wetlands which are more permanently inundated and contain stands of *Melaleuca* will be protected and included in the surrounds of the Murrayfield Airpark.

There are four smaller stands of *Melaleuca* that cannot be avoided by the development. These features are in the area required for the major runway and the adjacent grassed runway and will need to be removed. Construction of the runway will also involve the filling of a broad depression toward the middle of the site that contains scattered rush and sedge but no *Melaleuca*. It is proposed that a number of water features will be incorporated into the design of the golfcourse and these will be enhanced by the planting of native species. These will serve to replace the small *Melaleuca* stands.

5. Conclusion

This CER has identified a number of potential environmental impacts that could result from the construction and operation of the Murrayfield Airpark and Resort Complex. Analysis of these impacts have found them to be relatively minor and in the case of noise propogation and nutrient application there is a possible reduction in the scale of environmental impacts. As a result it is concluded that the proposed Murrayfield Airpark and Resort Complex will not unacceptably impact on the natural environment or on neighbouring residents.

1. INTRODUCTION

1.1 General Introduction

The Murrayfield Airpark and Resort Complex is an initiative of the Royal Aero Club of W.A. and Hawkview Holdings Pty. Ltd. The objective of the project is to create a facility within the Murray-Mandurah area that will service the needs of flyers. It will include a fully operational aerodrome and a resort to provide accommodation and leisure facilities for flyers and their guests and tourists.

The proposed site of the project is east of the Township of Mandurah in a predominantly rural area. One aerodrome runway already exists on the site and this has been operated by Hawkview for a number of years. The Royal Aero Club have also used the existing runway to train pilots on a regular basis since its upgrading in 1990. This aerodrome will essentially be expanded to two runways together with the required infrastructure to allow its regular and safe use by, propeller driven aircraft.

The resort complex will provide accommodation for approximately 400 people together with recreational and teaching facilities. The teaching facilities will be used in the training of pilots who will come from overseas and from country districts to gain flying accreditation. Recreational facilities will include a 9 hole golf course.

This Consultative Environmental Review (CER) describes the proposed Murrayfield Airpark in detail. The CER was required by the Environmental Protection Authority (EPA) so that the impact of the construction and operation of the facility on nearby residents and the environment could be assessed. The production of the document and its circulation will allow the general public to comment on the proposal.

The CER provides background information relating to the Airpark, the site on which it would be built, and its potential impact on the environment. It describes design features, and management strategies and policies by which these impacts will be managed or prevented. The aim of the projects initiators is to build a development which will have a minimal impact on neighbouring landowners and the environment.

1.2 Purpose and Structure of the Consultative Environmental Review

The purpose of this document is to provide information on the proposed Murrayfield Airpark development so that it can be assessed under the provisions of the Environmental Protection Act 1986. The Murrayfield Airpark was referred to the Environmental Protection Authority (EPA) by the proponent for this purpose.

The EPA decided to assess the proposal at a Consultative Environmental Review (CER) level of assessment. The preparation of an environmental impact statement and its release to the public for comment is a requirement of assessment at this level. The EPA issued a set of guidelines to assist the proponent in the preparation of the CER and this is presented in Appendix 1. The Consultative Environmental Review for the Murray Airpark project has been structured in accordance these guidelines.

1.3 The Proponent

The role of the proponent is jointly shared by the Royal Aero Club of WA Inc. and Hawkview Holdings Pty Ltd. This joint arrangement reflects the ownership of the land to be developed.

The Royal Aero Club of WA is the largest flying training organisation in Australia with over 30 aircraft on the flight line. The club has 1700 active and social members supported by an experienced staff of flying and ground instructors. The Club was formed 60 years ago and is an approved Cessna Pilot Centre. Figure 1.1 shows the administrative structure of the Royal Aero Club's WA Division.

Hawkview Holdings Pty Ltd is a private company whose primary aim is to provide flying facilities for its shareholders. It is independent of the Royal Aero Club of WA, however, the Royal Aero Club is a shareholder in Hawkview Holdings Pty Ltd. The company has twenty shareholders which are represented by a Board of Directors.

Resort Solutions Pty Ltd has a major role in the development and operation of the resort complex. The company will lease the land to be used for the development and as a leaseholder will be responsible for the resorts proper operation with regard to environmental issues. Resort Solutions Pty Ltd is a Western Australian subsidiary of RDG International, a resort development and management company with interests in major resorts and country clubs around Australia and New Zealand.

1.4 The Subject Land

The Murrayfield Airpark proposal involves 2 parcels of land being Lot 11 comprising 28.0046ha owned by Hawkview Holdings and Lot 12 comprising 162.1259ha owned by the Royal Aero Club. This gives a combined project area of 190.1305ha.

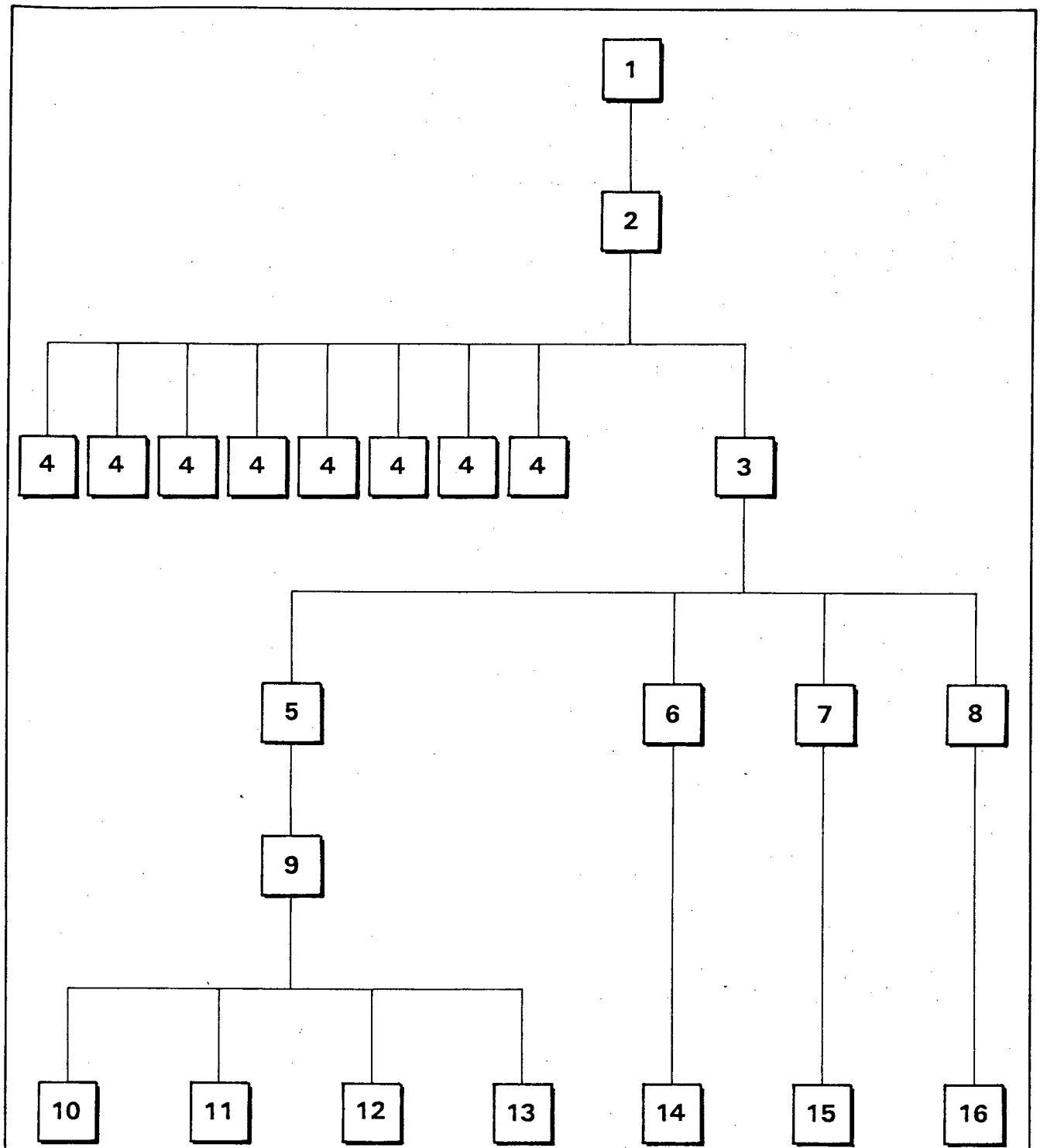
The project area is situated about 10km north-east of the township of Mandurah. It is bounded by Lakes Road, Nambeelup Road, and a road reserve for the proposed Redheads Road (Figure 1.2). Currently there are no plans to construct Redheads Road.

1.5 Statutory Requirements and Approvals

The successful development of the Murrayfield Airpark is dependent on a number of Statutory Approvals from various local and state Government Authorities. These are as follows:

Environmental Approval (Environmental Protection Authority)

Any project which has the potential to impact on the environment is required to be assessed by the EPA. In the case of the Murrayfield Airpark, the EPA has decided to assess the project at a Consultative Environmental Review level of assessment. After public consultation, the EPA will produce an Assessment Report on the proposal and, if



1	Members	9	Deputy Chief Flying Instructor
2	Committee	10	Ground Instruction
3	General Manager/Chief Instructor	11	Instructor Training
4	Sub Committees	12	Flight Instruction
5	Chief Flying Instructor	13	Operations - Flying
6	Chief Pilot	14	Charter Pilots
7	Chief Engineer	15	Maintenance Department
8	Secretary/Administrator	16	Administration Department

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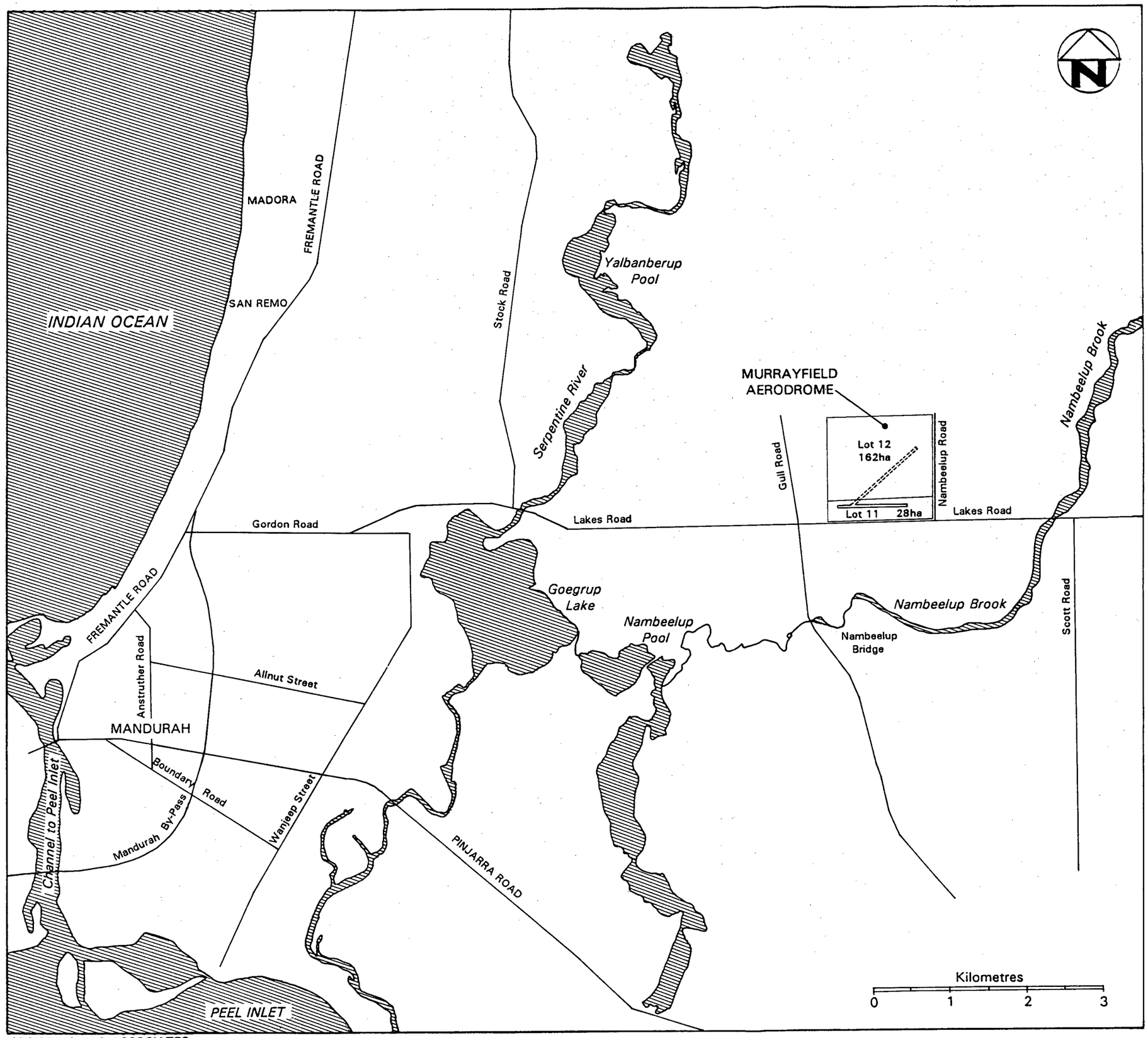
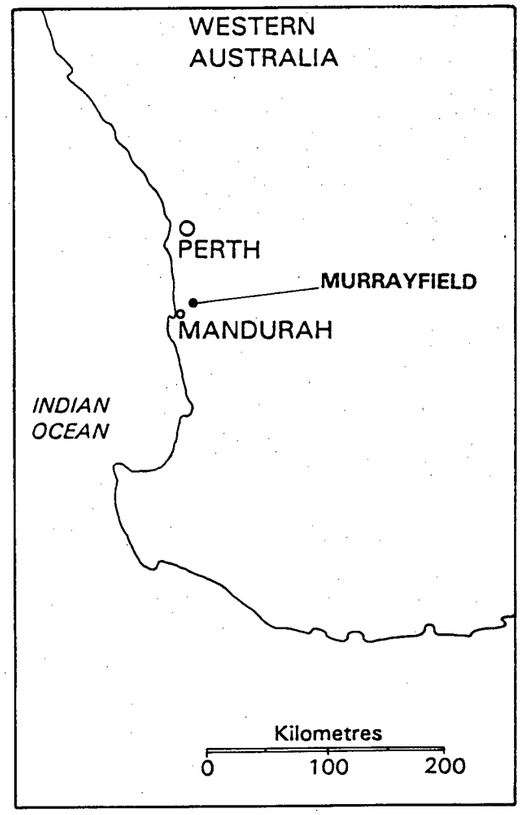
ADMINISTRATION STRUCTURE
ROYAL AERO CLUB OF WA

FIGURE 1.1





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MURRAYFIELD LOCATION
FIGURE 1.2

approved, the Minister for the Environment will set a series of conditions and procedures under which the project can be implemented.

Aerodrome Licence (Civil Aviation Authority)

An aerodrome must operate under a licence provided by the Civil Aviation Authority. An application to licence the Murrayfield Airpark was lodged with the Civil Aviation Authority in August 1989.

The licence will be issued following an initial commissioning inspection of the site. This licence is valid for a period not exceeding twelve months and re-issue is subject to the payment of a prescribed fee and a satisfactory audit review of the performance of the aerodrome operator.

Re-zoning of the Subject Land (Shire of Murray, Department of Planning and Urban Development)

The subject land is currently zoned rural in the Shire of Murray's District Zoning Scheme No. 4. An airstrip can be approved within this zoning, however a resort cannot. Consequently the Shire of Murray has initiated Amendment No. 6 to Scheme No. 4 to re-zone Lots 11 and 12 to a special site. The site would then only be for the purpose of an aviation park and associated support facilities as approved by Council.

Amendment No. 6 also has to be processed by the Department of Planning and Urban Development and this will be done in parallel with the environmental assessment process. Amendment No. 6 will not be granted final approval until environmental approval has been granted.

Bore Licence (Water Authority of Western Australia)

The resort and golf complex will require a source of water for irrigation and general use. Thus the development will require an extractive licence under the Rights In Water and Irrigation Act 1914.

Private Sewerage Scheme (Public Health Department)

As Murrayfield Airpark is well away from the township of Mandurah it cannot be connected to reticulated sewerage. Subsequently the development will require its own sewerage treatment system which will need to be licenced under the Health Act 1911.

Planning Approval (Shire of Murray)

The project needs to obtain developmental approval from the local authority before proceeding.

Subdivision Approval (Department of Planning and Urban Development)

Any subdivision required to achieve the development objectives of the proposal, including the issue of any long term lease will require approval from the Department of Planning and Urban Development

1.6 Management Responsibility

Aerodrome

The Royal Aero Club currently is and will be the airfield manager who's responsibilities will include all aspects of the management of the airfield and airside operations. This is by agreement with Hawkview Pty Ltd.

The airfield will be licensed by the Civil Aviation Authority (CAA) after commissioning. The preparation of a manual describing the operational procedures of the airfield is a requirement of the license. That manual will contain all aspects of airfield operation including safety and will describe and make recommendations regarding the condition of runways and movement areas. If the operating procedures described in the manual are not adhered to there is the potential for the aerodrome licence to be revoked.

Resort Complex

Resort Solutions Pty Ltd will have complete responsibility for the management and operation of the resort complex, including the operation of the golf course. The company will lease the land to be used for the resort complex from the Royal Aero Club of W.A.

2. NEED FOR THE DEVELOPMENT

The growing popularity of flying for business and recreational purposes worldwide, has created a demand for facilities specifically developed for flyers. The Royal Aero Club presently offers, and is actively marketing, a training course to commercial licence standards, in the United Kingdom, Denmark, Switzerland, Germany, Japan, Malaysia, Indonesia and Singapore. The flight training course of some 48 weeks provides for 220 hours experience on twin engined aircraft and instrument rating. As a result the club has experienced a substantial increase in demand for pilot training, to the point where existing facilities at Jandakot are operating capacity and cannot cope with additional demand. Also the proposed Murrayfield Airpark will offer facilities that could not be constructed at the Jandakot Airport.

The Royal Aero Club has also experienced a substantial increase in demand for facilities from its growing local membership. The Club currently has a membership approaching 2000, a permanent staff of 50 and it is now flying in excess of 30,000 hours each year.

It has become apparent that the Jandakot Airport has limitations with respect to the numbers of aircraft movements it can accommodate even with some expansion. This has impeded to some degree the continued growth of the club. Through the Club's strategic planning it has been recognised that an airfield needs to be established away from, but within reasonable distance of, the existing Jandakot airfield to serve its membership and to provide commuter services to the Perth airport from the future southern metropolitan region.

The establishment of a substantial aerodrome at Murrayfield will create an integrated facility offering a full range of services to flyers. Market studies have determined that a resort orientated development in association with the aerodrome will enhance its attractiveness to overseas and country student pilots. In addition it will provide facilities for Aero Club members. The resulting development concept is an Airpark.

Airparks equivalent to the proposed Murrayfield Airpark have operated successfully for some 20 years in the United States of America and Canada. The concept has been slow to emerge in Australia, perhaps due to a smaller, more widely spread population, and the promotion of more traditional leisure and recreational facilities. However, international trends indicate that with population growth, specialty resorts such as the proposed Murrayfield Airpark will be in great demand in Australia in the 1990's.

The Murrayfield Airpark is designed to meet local demand for sports flying facilities and to provide the ability for the Royal Aero Club to meet international demand for its flight training courses. The meeting of this demand can only be of positive influence to the region and the state of Western Australia.

3. ASSESSMENT OF ALTERNATIVES

3.1 Alternative Development Locations

In 1988, the Executive of the Royal Aero Club sought to identify a suitable area of land for the development of a second airfield and support facilities to supplement those offered at Jandakot. A site at Port Kennedy to the south of Warnbro Sound was investigated but after negotiations it was found to be inadequate in terms of available space for aircraft operations. A second site between Lake Cooloongup and Lake Walyungup in Rockingham was found to be suitable however it was decided that the extension of urban development along the south-western corridor would eventually be in conflict with aircraft operations.

The proposed location for Murrayfield Airpark meets the requirements of the Royal Aero Club. The location was selected because of:

- reasonable proximity to the existing facilities at Jandakot;
- location within the southern portion of the training area proclaimed by the Civil Aviation Authority;
- the existence of a private runway on Lot 11, out of which the Aero Club already operates, which also has a hangar that could be readily integrated into an overall airpark proposal;
- good road access to Perth and Mandurah;
- low level of human habitation in the immediate vicinity;
- adequate availability of land for development of a functional airpark, and for an integrated leisure and flying facility;
- lack of turbulance associated with the Darling Scarp to the East; and
- no constraints with regard to overhead elevated high voltage powerlines.

3.2 Development Options

The project consists of a resort and aerodrome which have been designed to enhance the utilisation of one another. The option of having an airfield with no resort complex has been considered but it does not offer the opportunities required for attracting overseas and country trainee pilots.

A key factor in the viability of the proposal is its integrated nature. The Murrayfield Airpark needs to be able to offer high quality accommodation and recreational facilities to attract student pilots from overseas and from country areas. These have to be in

very close proximity to flying facilities for the sake of efficiency and convenience to students.

3.3 The "Do Nothing" Option

The do nothing option would essentially involve leaving the site to be used for the grazing of cattle with the existing private airfield continuing to operate within its design capacity.

If this was to occur the following opportunities would be lost:-

- The provision of 80 temporary jobs in construction of the Airpark and 150 full time and 150 part time permanent jobs in the operation of the complex in a region with higher unemployment than the State average (Section 6.6.1).
- Benefits in the form of foreign exchange and tourism that would flow from the use of the site as a training centre for overseas pilots (Section 6.6.2).
- The alleviation of growing congestion at Jandakot Airport near Perth (Section 2).
- A tourist and recreation facility for which there is an identifiable demand (Section 2).
- The reduction and control of existing nutrient inputs from the site into the Peel-Harvey Estuary system (Section 6.3).
- The reduction and control of existing noise levels experienced by residents immediately to the west of the existing runway (Section 6.2).

4. DESCRIPTION OF THE DEVELOPMENT

4.1 Development Concept

The proposed Murrayfield Airpark is a unique concept to Western Australia which brings together two distinctly separate activities to complement one another. These activities are flying and resort and leisure activities. The resulting development concept is a specialty resort with flying as a central theme.

It is anticipated that the Airpark with its range of recreational facilities will attract many international groups for flight training, sports flying and international air shows. This coupled with strong local demand for flight training and recreational flying facilities will ensure the viability of the project.

It is envisaged that the resort will be of the highest standard and will include sports facilities for golf, tennis, squash, archery and swimming. The resort will contain a gymnasium, restaurants, convention facilities, and theatre type lecture rooms. In addition the Royal Aero Club and Hawkview Pty Ltd will have members facilities.

4.2 Aerodrome Complex

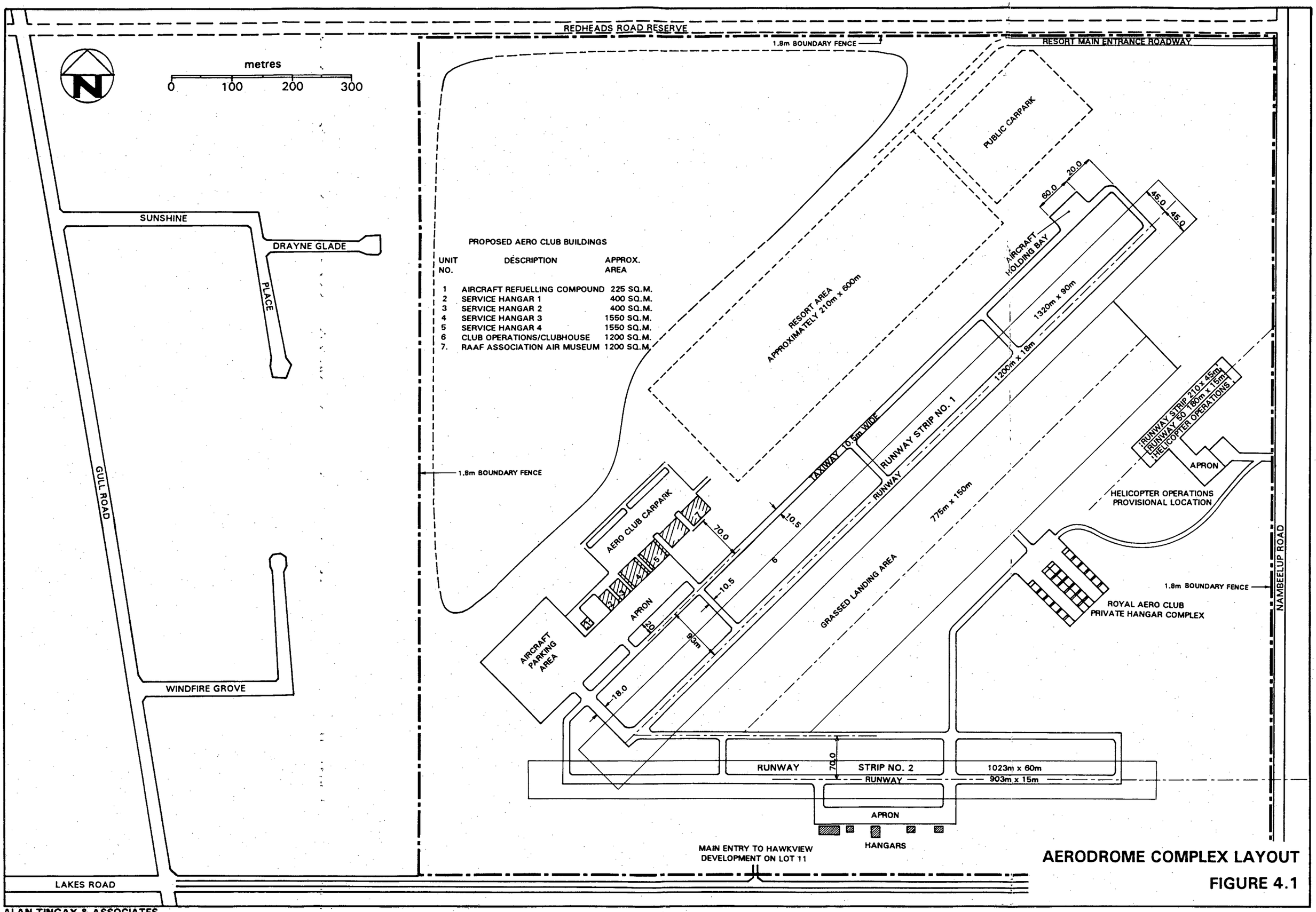
4.2.1 Facilities

The aerodrome will provide general aviation facilities that are able to handle aircraft with a maximum take-off weight of up to 5,700kg. This equates to single and twin engine propeller driven aircraft with a maximum capacity of about twelve people. The aerodrome will be equipped to operate during both day and night, however, night time operations will be limited.

Generally the aerodrome occupies the central and southwest corner of the development site and will consist of three runways and the facilities normally provided for aircraft operation. The layout of the aerodrome complex is presented in Figure 4.1. The design of the aerodrome is in compliance with standards and acts concerning civil aviation. The most significant of these are the Civil Aviation Regulations, Civil Aviation (Building Control) Regulations, Air Navigation Regulations, and Air Navigation Orders.

Runways

The number and orientation of runways has been decided upon on the basis of achieving the maximum availability of the runway system in all weather conditions. There will be two sealed runways that will be usable in both directions, one oriented in a north-east, south-west direction (No. 1) and the second in a east-west direction (No. 2). There will also be a grassed runway which will parallel runway No. 1. Each runway will have associated fully graded surroundings. For runway No. 1 this will be 90m wide and for runway No. 2 this will be 60m wide.



AERODROME COMPLEX LAYOUT

FIGURE 4.1

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Both sealed runways are designed for operations under what is known as visual flight rules weather conditions. Runway 1 will be provided with runway lighting to permit limited night operations.

Taxiways

Taxiways will be provided to give access along the lengths of both runways and also to provide for aircraft movements to all parts of the movement area and servicing areas with a minimum obstruction of the runways. The layout of taxiways is shown on Figure 4.1.

The width of taxiways will not be less than 10.5m except for several cross runway feeders. The minimum taxiway strip width will be 39m. The minimum separation distance between taxiways and runway centre lines will be 87m for runway No.1 and 57m for runway No.2

Drainage of Aprons

The Royal Aero Club are aware of the need for facilities which will prevent the spread of pollutants via the aerodrome drainage system into the receiving environment. The only areas that have the potential to contribute pollutants to drainage waters are aprons on which refuelling and servicing of aircraft are performed. Drainage facilities will be installed to prevent the spread of fuel and oil resulting from any spill within apron areas. They will include flame traps, oil traps, and interceptor pits.

The apron drainage system will be designed to comply with the relevant Commonwealth, State and Local government regulations concerning pollution control requirements.

Aircraft Ground Facilities

Light aircraft tie-down facilities will be provided to secure aeroplanes against damage resulting from their being blown off the apron parking positions by strong winds. These will be provided on all paved aprons.

Heliport

Provision has been made in the layout of the aerodrome for a Heliport (Figure 4.1). The standards for helicopter facilities to enable the airfield to be licensed as a Heliport are under preparation by the CAA. The detailed design will be carried out in consultation with the CAA in order to meet their requirement for licensing.

Control Tower

Operation of the airfield will be under the general rules for non-controlled operation. The initial plans for the airfield therefore do not include a Control Tower.

Access

The point of access to the airfield will be at the general access point to the resort in the north eastern, corner of Lot 12 (Figure 4.1). Access to the Hawkview complex on Lot 11 will be at a point approximately 800m before the junction of Lakes Road and Nambellup Road.

Auxiliary Services

Auxiliary services will include electrical power, water supply and sewerage.

Electrical power will be supplied from the State Energy Commission of Western Australia (SECWA) 22kV power lines which run along the southern and eastern boundaries of the site. SECWA are already supplying the power from this source to the Royal Aero Club facilities on Lot 11. Discussions with the SECWA indicate that these power lines have sufficient capacity to supply the airfield requirements. Stand-by power will provide for runway lighting, for radio communications and to maintain water supplies.

The Royal Aero Club and aerodrome will require only small amounts of potable water. This will be obtained either from rain water or from water trucks until such time as the resort is established and permanent water supply plant is installed. The supply of potable water to the resort complex is discussed in Section 4.3.1 .

Until the resort is established sewage disposal will be by means of septic systems. This is the current method of disposal utilised by Hawkview Pty Ltd on Lot 11. When the resort is constructed there will be a main sewage plant which will handle all the sewage for Lot 12 (see Section 4.3.3). Sewage from the Royal Aero Club facilities will be pumped as required where existing ground levels do not permit a gravity flow system. If it is not economical to connect new facilities within Lot 11 to the main treatment system they will be serviced by their own self contained sewage treatment plant.

Other Facilities

Communication facilities are vital for the safe and efficient operation of an airfield. It is therefore planned to provide a radio station operating on the VHF air band, as approved and licensed by the Department of Transport and Communications.

The recent advent of small and inexpensive Global Position System units has tended to render many other radio navigation aids redundant. It is therefore not planned to include any permanently sited navigation aids on the airfield.

The Royal Aero Club have already established a telephone line that includes a direct link between Jandakot and Murrayfield which operates from the Royal Aero Club Hangar on Lot 11.

Meteorological information is of vital importance to the safe and efficient operation of the airfield. In consultation with the Meteorological Bureau the Royal Aero Club will establish a data recording station on the Aerodrome. This data will be passed daily to the Meteorological Bureau in Perth. Meteorological information for the purposes of air operations will be obtained from CAA sources daily or as required.

4.2.2 Fuel Storage

Aviation fuel will need to be stored on site to supply aircraft based at Murrayfield. An above ground tank with a 55,000 L capacity will be provided. The tank will have above ground inlet and outlet fuel dispensing equipment. Hawkview will also require a smaller storage facility most likely no larger than 20000L capacity.

All of the refuelling installation will be constructed within a bunded area with sufficient storage to hold in excess of the maximum amount of fuel to be stored. Oil interceptor traps will be provided at refuelling areas to avoid any possibility of hydrocarbon contamination of surface or groundwaters.

4.2.3 Irrigation

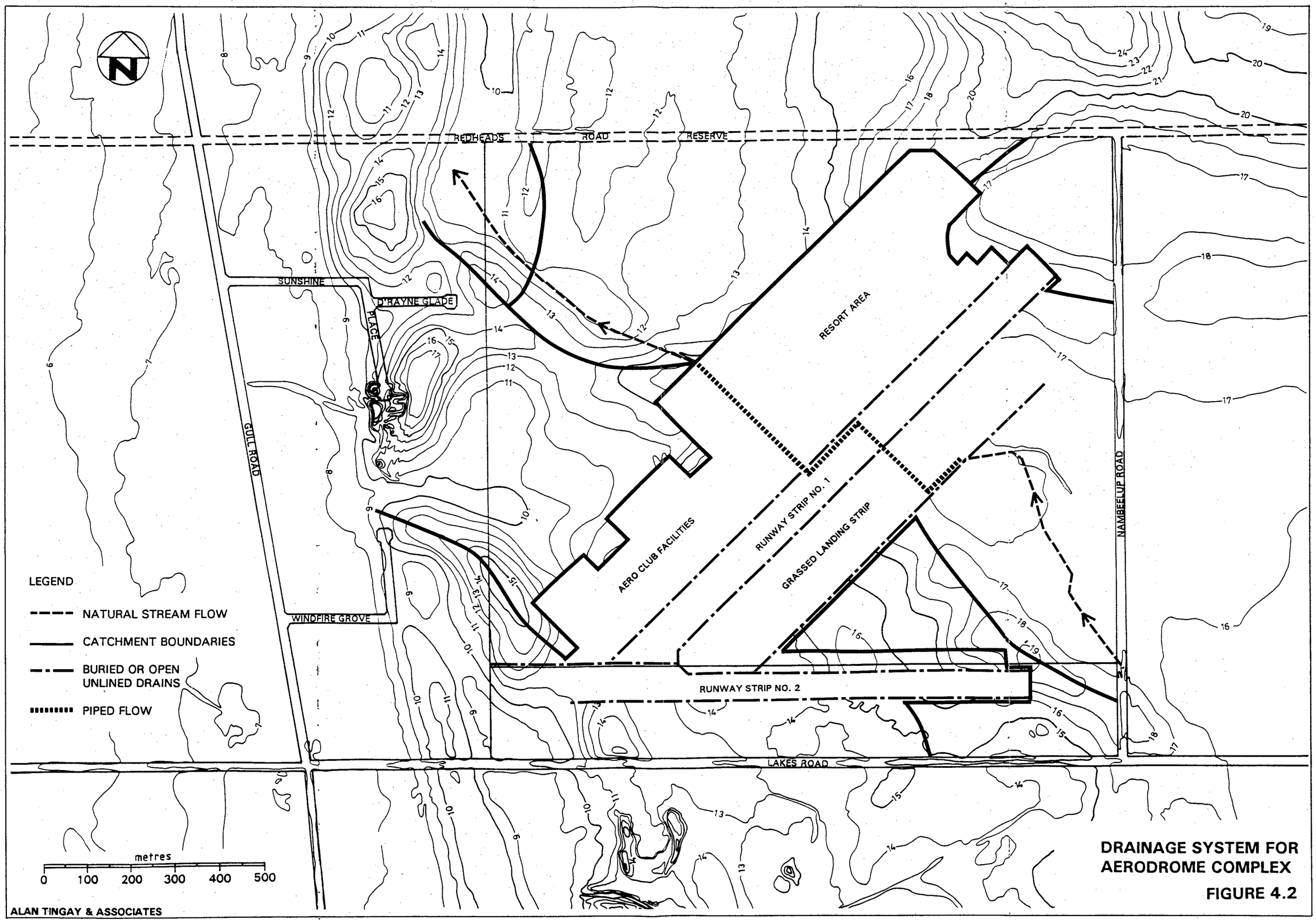
The grassed airstrip is the only significant area within the aerodrome complex that will require irrigation. This will be irrigated with treated effluent from the sewage treatment plant plus bore water if required (Section 4.3.3). A species of grass requiring relatively little watering such as Kikuyu will be selected to minimise the need for irrigation over this area.

4.2.4 Surface Water Drainage

Drainage from the aerodrome complex has been designed to ensure that no additional quantities of water flow off the site and that pre-existing drainage catchments and paths are retained after the development is complete. This will involve conducting rainwater runoff from hard stand areas and buildings into drainage systems that enable their percolation into the ground.

It is proposed that runoff from the runways be conducted down V drains running the length and around the perimeter of runways. These will be unlined to enable runoff to enter the ground. The drains will also be designed to allow water to spill out onto areas adjacent to runways should they overflow during high rainfall events. Water should then soak into the ground rather than flow away, as soils on the site have good free draining characteristics (Section 5.1.4.). The proposed V drain system and the direction of water flows is shown on Figure 4.2.

A piped drain will be laid beneath the middle of the main runway to direct water from the south eastern corner of the site to the north western corner (Figure 4.2). This will conduct water that would have flowed through the resort and aerodrome areas via a man-made channel (refer Section 5.1.6). It will not receive any runoff from runways or hardstand areas associated with the aerodrome. The purpose of this piped drain is to



DRAINAGE SYSTEM FOR AERODROME COMPLEX

FIGURE 4.2

prevent the build up of water in the south eastern corner of the site and maintain current flow patterns.

4.3 Resort Complex

4.3.1 Facilities

The resort facility has been designed to provide accommodation and recreational facilities, including a golf course, to visitors and to members of the Royal Aero Club of WA and to visitors. Figure 4.3 shows the layout of the resort complex and the range of facilities it will contain.

Accommodation

There will be a total of 140 residential units capable of accommodating about 370 people. This will consist of two groups of thirty eight condominiums and a hotel with 120 rooms. The resort building will also provide convention facilities, restaurants and indoor sporting facilities.

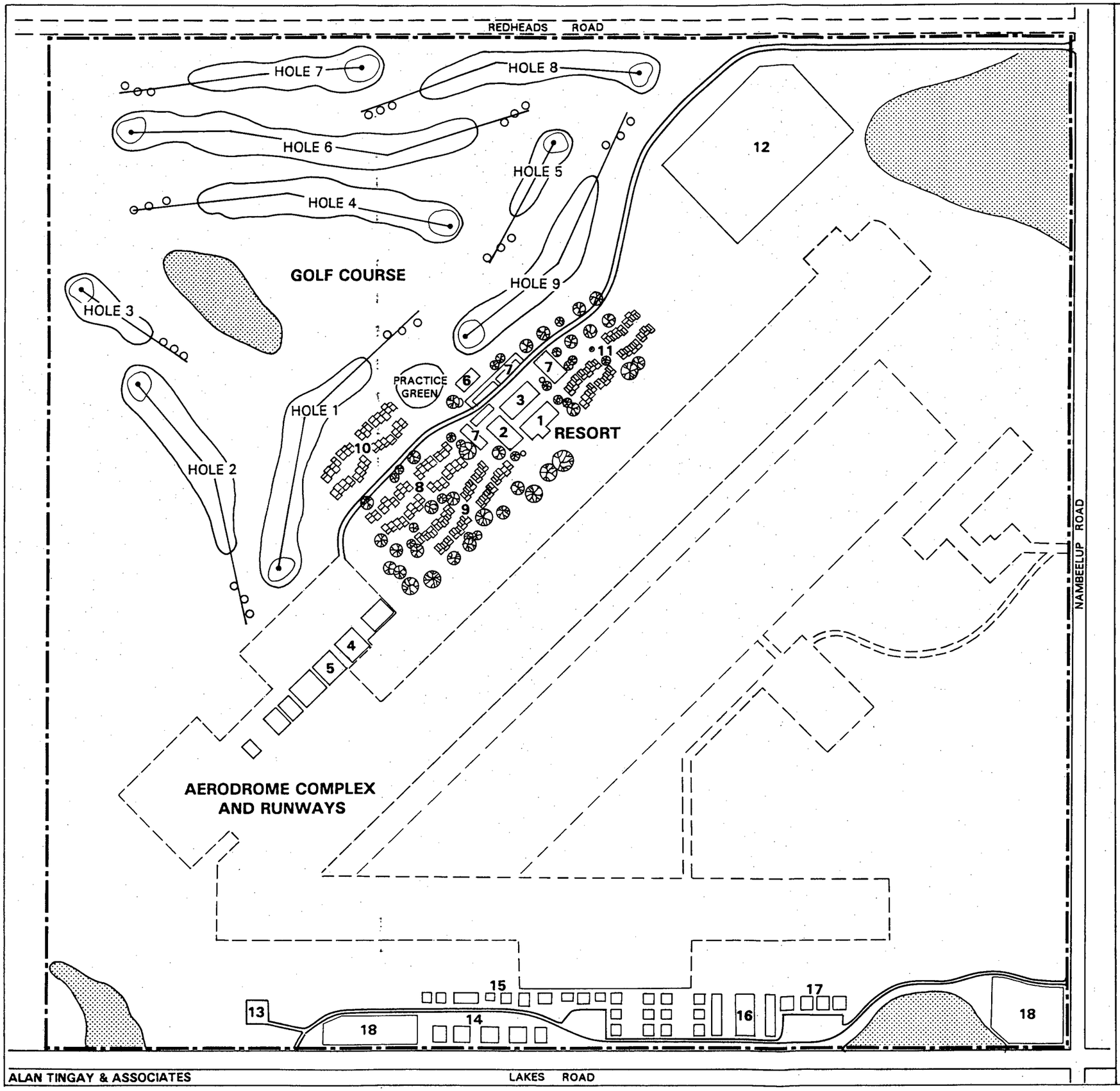
Auxiliary Services

Electrical power will be supplied from the SECWA 22kV power lines which run along the southern and eastern boundaries of the site. The total power demand for the resort has not yet been determined but it is anticipated that there will be sufficient capacity to supply the resort's demands. Stand-by power will be provided to ensure that the resort can operate if the area experiences a power cut.

Water will be obtained from bores which will be drilled onsite, probably toward the centre of Lot 12. There are abundant supplies of ground water within the region and the water is of reasonable quality, with between 100-800 mg/L of Total Dissolved Salts (Section 5.1.5). Treatment will be necessary for potable water supplies, as the water supply has an impurity in the form of iron. The most appropriate form of water treatment has not yet been determined but it is probable that it will be a plant using an electrodialysis reversal principle.

Other Facilities

There will be two club houses to service the membership of organisations that will utilise the facilities at the Murrayfield Airpark, one each for the Royal Aero Club, Hawkview. These may have associated facilities such as barbecue areas. A clubhouse will also be provided as part of the golf course. Carparking will be provided toward the north eastern corner entrance and near the westernmost portion of the resort area.



ALAN TINGAY & ASSOCIATES

N

metres

0 100 200 300

LEGEND

1	RESORT - STANDARD 2-STOREY
2	RAC CLUBHOUSE AND LECTURE FACILITY
3	CONVENTION/GYMNASIUM
4	RAC OPERATIONS BUILDING
5	RAC SERVICE HANGAR
6	GOLF CLUBHOUSE
7	CARPARK
8	CONDOMINIUMS - 30
9	RESORT UNITS - 52 PRESIDENTIAL UNITS - 2
10	CONDOMINIUMS - 30
11	RESORT UNITS - 54 PRESIDENTIAL UNITS - 2
12	PUBLIC CARPARK
13	PUBLIC VIEWING AREA
14	HAWKVIEW CLUBROOMS, LUNCH BAR & OFFICES
15	EXISTING & FUTURE HANGARS FOR HAWKVIEW MEMBERS
16	RENTAL HANGARS
17	AIRCRAFT SALES, DISPLAY, REPAIRS & FUEL OUTLET
18	POTENTIAL CHALET DEVELOPMENT

WETLAND

SCHEMATIC LAYOUT OF RESORT AND GOLF COURSE

FIGURE 4.3

4.3.2 Surface Water Drainage

The resort complex will be landscaped to maximise the quantity of stormwater which percolates into the ground by minimising any surface flows. This will be achieved by promoting the infiltration of stormwater into the ground within and around the immediate periphery of the resort buildings. This practice will also reduce the need to irrigate during the hotter months by utilising stormwater for watering purposes.

It is proposed that where possible water harvesting from buildings and sealed areas will be practiced. Stormwaters from these areas will be conducted into a series of small dish-shaped impoundments located within gardens scattered around the resort. The impoundments will capture a proportion of the stormwater flow and hold it long enough to allow infiltration into the ground. They will be vegetated with plants that do not require irrigation during the dry conditions experienced during summer. The layout of these features will be decided upon during the detailed landscape planning of the resort.

Other features that promote the infiltration of stormwaters into the ground will include soakwells, and porous pavements together with an absence of curbing around roadways.

4.3.3 Sewage Treatment

The resort will be serviced by a main sewage treatment plant which will be capable of servicing 140 residential units with an additional allowance for an extra 100 persons within other facilities. It will be an intermittent extended aeration treatment system equipped for phosphorus removal and chlorination of the final effluent. A water storage tank with two days capacity will be constructed and sludge will be drawn off to under-drained sludge drying beds.

It is estimated that the resort will generate an average of 80 kilolitres of wastewater each day. This will need to be disposed of seven days a week throughout the year. The effluent will be designed to meet Health Department criteria for irrigation of recreational and landscaped areas and will contain approximately 2mg/L of phosphorus. This equates to about 60kg of phosphorus per annum.

4.3.4 Solid Waste Disposal

The nearest solid waste disposal site is north of Pinjarra and it is expected that refuse from the operational development will be deposited there. It is expected that the transport of waste to the site will be the responsibility of the Resort Manager, Resort Solutions Pty Ltd. The sewage treatment plant will produce a relatively small volume of solid waste. This will be transported to the Pinjarra Landfill.

4.3.5 Access

Access to the Resort will be from Nambeelup Road, adjacent to the junction of Nambeelup Road and the reserve for Redheads Road.

4.3.6 Golf Course

Layout

The golf course will consist of 9 holes which will be set in surrounds containing natural and artificial wetlands. The course starts outside the golf club rooms and winds around the north west section of the site in a clockwise direction. The schematic layout of the golf course is presented in Figure 4.3. Detailed design will occur just prior to, and during, its construction.

Care will be taken to incorporate as much of the natural vegetation on the site as is practical in the golf course area. Wetlands and as many trees as possible will be retained. The golf course has been kept to areas that are elevated as much as possible so as to avoid flooding, however some filling will be required to provide an even surface for play.

Surface Water Drainage

Flows of surface water originating from the golf course grassed areas are not anticipated as soils are generally permeable and drain readily (Section 5.1.4). A potential difficulty is that soil amendment may make these soils less permeable, thus attention will be paid to ensuring that soil amendment is done in such a way as to ensure that grassed areas do not shed water.

Plantings

It is proposed that the areas surrounding the golf course will be heavily planted with native shrubs and trees. Plantings will serve to enhance the appearance of the golf course and promote the uptake of any surface waters and shallow groundwaters.

Melaleuca species will be planted in and around low lying areas especially where surface waters may flow. The perimeter of the site will be heavily planted with quick growing eucalypt species to provide a visual barrier between the golf course and neighbouring land owners and public roads.

Irrigation

It is proposed that all greens, tees and fairways will be automatically reticulated by a system which draws on water from bores and possibly artificial lakes established within the golf course.

4.5 Construction

4.5.1 Aerodrome Complex

Essentially the construction of the aerodrome complex will be an earth moving exercise centred on the construction of the runway systems. The bulk of the earthworks will be

a cutting and filling exercise designed to be a balanced operation. The provisional schedule for the construction of the airfield is presented in Table 4.1.

The cut and fill and consolidation works will result in the formation of aircraft movement areas which will then be surfaced with imported sub-base and base materials.

Several types of earthworks materials will be required from outside sources. These are as follows:

i) 1100 m^3 of Alcoa red mud or approximately 75 truck loads to stabilise the grassed landing area.

ii) Approximately 15600 m^3 or 1050 truck loads of limestone to provide sub-base material for movement area construction.

iii) Approximately 8000 m^3 or 520 truck loads of gravel for movement area construction.

Bulk earthworks and pavement construction will extend over an 11 week period. This means that an average of 210 trucks per week, 42 per day, or 5 each hour will be arriving and leaving the site during that period. Materials will be sourced at the most economical locations which will probably be in the coastal region and from gravel deposits in the Darling Scarp areas. These sources are expected to be within a radius of 25km from the site.

4.5.2 Resort Complex

It is proposed that fencing, landscaping and construction of the runway be commenced in April of 1992. Earthworks associated with the golf course and the resort will be concurrent with the earthworks related to the aerodrome complex. It is expected that about 1000m^3 of Alcoa red mud will be required for the golf course and other grassed areas associated with the resort. Construction of buildings will follow commencing in about September 1992 and lasting about 9 months. Construction of the condominiums will commence in late 1993 and last about 12 months.

TABLE 4.1

Item	Description	Start Date 1992	Finish Date 1992	Period (weeks)
1	Detailed airfield design	1 January	30 April	17
2	Contract documentation	1 March	30 April	6
3	Tender & Award	1 May	1 June	4
4	Bulk earthworks	15 June	10 August	8
5	Drainage	15 June	10 August	8
6	Pavement construction	13 July	7 September	8
7	Sealing	10 August	21 September	6
8	Airfield details: markers etc	24 August	5 October	6
9	Miscellaneous works: fencing, roads, etc.	13 July	5 October	12
10	Aero Club Complex, operations building, clubhouse, fuelling installation	29 June	5 October	14
11	Commission & open airfield	6 October		

The timetable in Table 4.1 is an estimate only and is dependent on the gaining of the relevant authorities such as the EPA and the Department of Planning and Urban Development.

5. THE EXISTING ENVIRONMENT

5.1 Physical Environment

5.1.1 Climate

The Murray-Manduarh area experiences a Mediterranean climate with mild wet winters and hot dry summers. Mean annual rainfall ranges from about 1100-1200mm on the Darling Scarp to about 850-900mm on the coast with the latter figure being more typical of the development site.

A wind rose for the area are presented in Figure 5.1. In summer easterly winds predominate and produce hot dry conditions. During winter the winds blow mostly from the south west and bring 90% of the annual rainfall.

5.1.2 Geology

The development is located on the Swan Coastal Plain which is the surface expression of the Perth Basin. This basin contains rocks of sedimentary origin and includes shales, sandstones and limestones. The Perth Basin abuts the Yilgarn Block whose surface expression is the Darling Plateau. The Darling Fault, which roughly parallels the coast, separates these two geological provinces.

5.1.3 Geomorphology

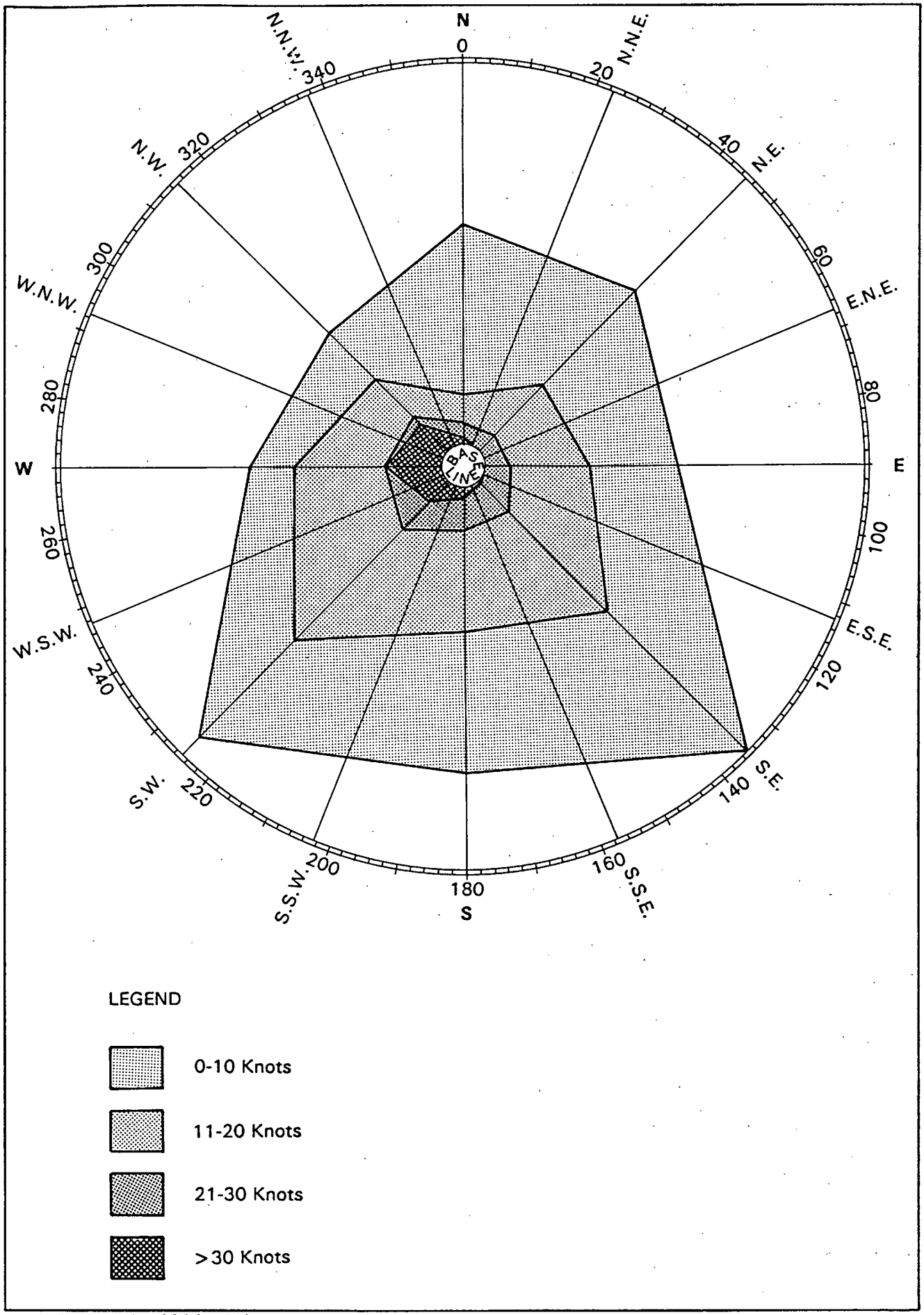
A series of alluvial and aeolian deposits cover the surface of the Swan Coastal Plain. These deposits are described in detail by McArthur and Bettenay (1960). Generally they consist of a series of alluvial deposits in the east and aeolian dune deposits to the west.

The development site is located within the Bassendean Dune System which contains low hills of leached quartz sands interspersed with sand flats and seasonal wetlands. The development site contains all of these morphological units (Figure 5.2).

To the east of the Bassendean Dune system are the Ridge Hill Shelf and Pinjarra Plain. These are composed of coalescing alluvial fans and riverine deposits derived from the erosion of the Darling Scarp. To the west of the Bassendean Dune system is the Spearwood Dune system. The Spearwood Dunes are hilly and overly aeolian limestone and are composed of yellowish brown quartz sand. The Quindalup Dune system fringes the coastline and consists of the more recent unconsolidated aeolian deposits on the coastal plain.

5.1.4 Soils

The soils of the Mandurah-Murray Region and of the development site are described in the Department of Agriculture Resource Management series (Wells, 1989).



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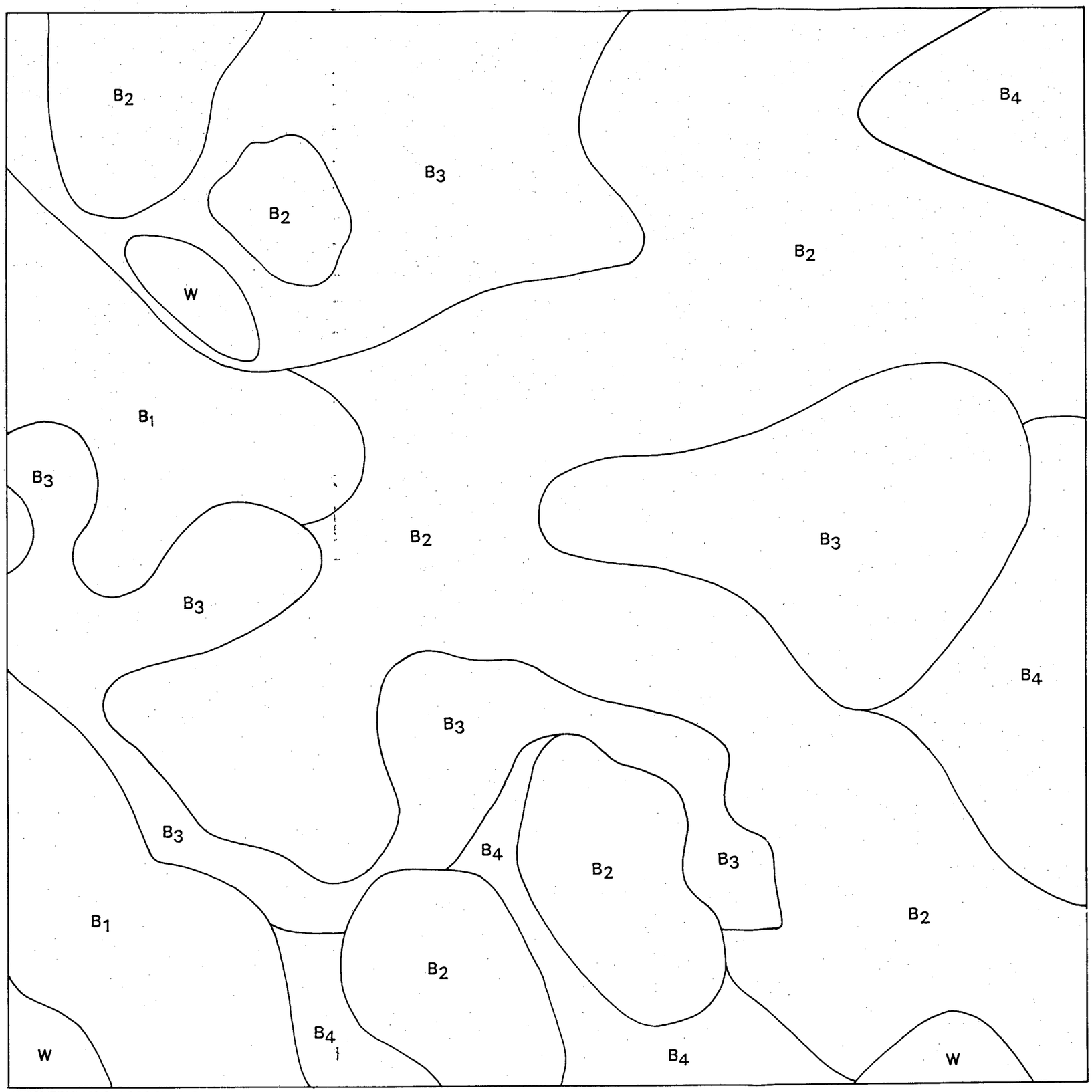
MURRAYFIELD WINDROSE

FIGURE 5.1



LEGEND

- B_1 Very low relief dunes and areas of undulating sand plain
- B_2 Sand plain
- B_3 Broad depressions and ill-defined stream channels
- B_4 Broad poorly-drained plain
- W Wetland

metres

0 100 200

N

MURRAYFIELD MORPHOLOGICAL UNITS

FIGURE 5.2

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The site contains deep, grey, quartz sands which are mostly bleached. These sands are often underlain by iron-organic hardpans which have developed close to the shallow watertable which is often only 1-2m below the ground surface. Areas of broad, poorly drained, plain usually have a grey clay layer at less than 1m depth which supports a perched water table. Uniform fine textured soils containing abundant organic material are associated with wetlands.

Bassendean Sands on the site are typically permeable and have little ability to retain subsoil water and as a result are well drained. They have a low nutrient availability which stems from the soils inability to retain nutrients. Consequently Bassendean Sands can be expected to have low to very low phosphorus retention indices (PRI's) as defined in Wells & King (1989). This is important when considering the environmental implication of the application of nutrients to the site in the form of fertilisers and from effluent disposal systems.

5.1.5 Hydrogeology

There are two water-bearing formations that are capable of supplying water to the development. These are the Bassendean Sand which is the uppermost unconfined aquifer and the Leederville Formation which underlies the Bassendean Sand. A detailed review of the hydrogeology of the site and a discussion of the impacts of drawing water from each of the aquifers is presented in Appendix 2.

Bassendean Sands

The Bassendean Sands are recharged directly by the infiltration of rainfall. Recharge rates are expected to be high; about 20 to 30% of average rainfall. Water moves through the permeable soil profile toward low-lying areas, discharging to wetlands and drainage courses. The open waters in low-lying wetlands are the surface expression of the water table in winter.

Water from the Bassendean Sand is essentially fresh with salinities within the range of 100 to 800mg/L Total Dissolved Salts. The waters are commonly acidic and can contain high concentrations of iron oxide. Total Nitrogen concentrations are low being less than 5mg/L. Total Phosphorus concentrations are also low, ranging from <0.01 to 0.16 mg/L.

The hydraulic head of waters in the Bassendean Sand is larger than that of the Leederville Formation and there is the potential for water to seep down into the underlying formation.

Leederville Formation

The Leederville Formation is probably recharged from the overlying Bassendean Sand. There is some brackish water near the top of the formation about two kilometres west of the site, probably due to the proximity of the Rockingham Sand which contains saline water.

At depth, the groundwater in the formation is confined by siltstones and shales. This water is expected to be fresh with salinities in the range of 400 to 800mg/L Total Dissolved Salts. Results of water analyses from nearby bores indicate that there are low concentrations of nitrogen and phosphorus in waters of the Leederville Formation.

5.1.6 Hydrology

The Murrayfield Airpark is within the catchment of the Serpentine River which flows into the Peel Inlet via Lake Goegrup (Figure 5.3). The Serpentine River drains the southern part of the Perth Metropolitan area and northern parts of the Mandurah and Murray Shires.

The development site is generally low lying and contains a number of broad poorly drained areas, wetlands and poorly defined ephemeral stream courses (Figure 5.2). Rains which fall on the site move through the permeable dunal sands and into the underlying aquifer. Groundwaters then flow toward low-lying areas, discharging to wetlands and drainage courses. In summer the water table drops and wetlands and winter-wet areas dry out.

The most elevated portion of the site is a low ridge which cuts diagonally across the site in a NE-SW direction. This ridge combined with another which trends SW-NE divides the site into SIX separate catchments. These catchments are shown in Figure 5.4.

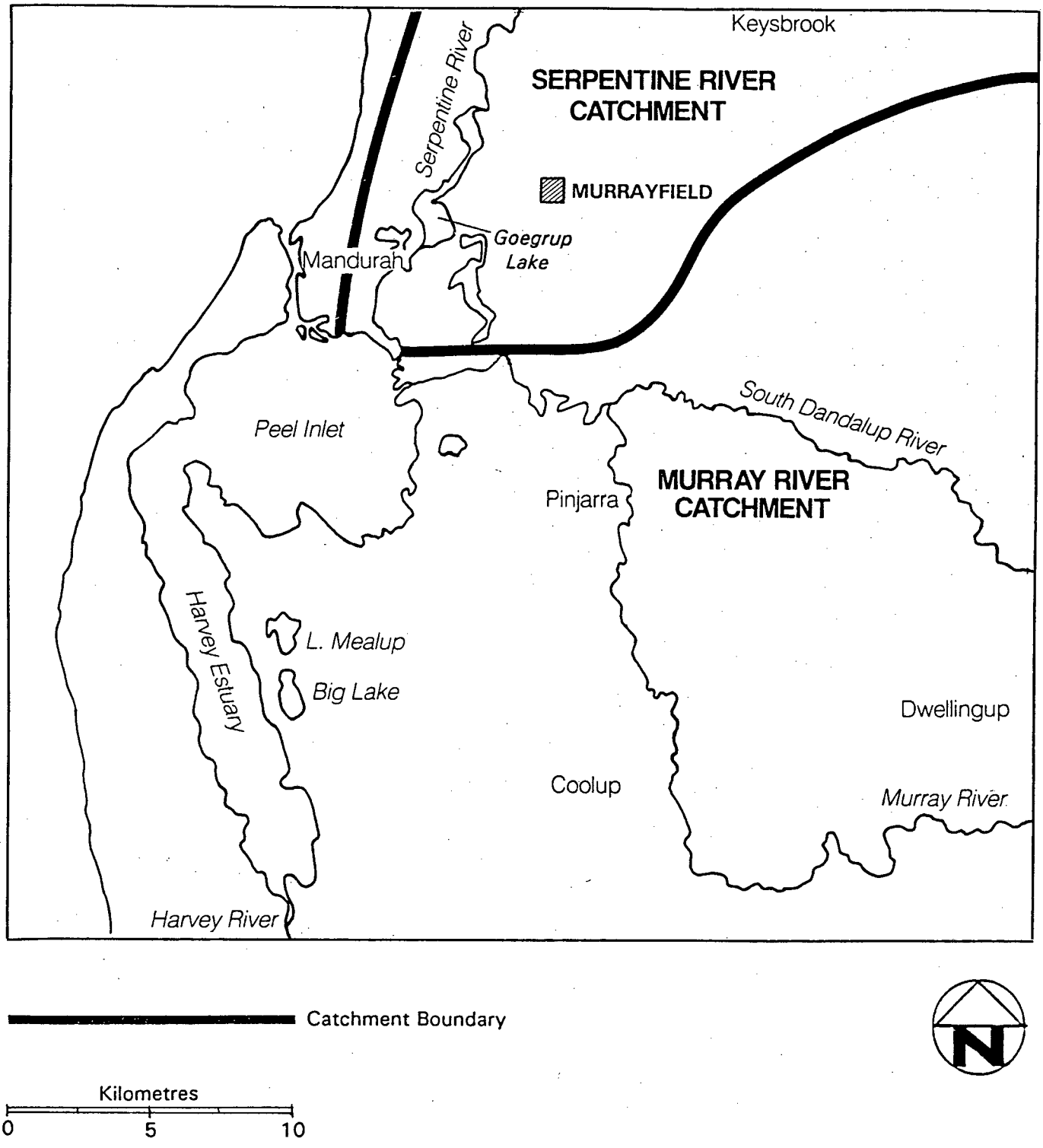
Catchment 1 has a total catchment area of about 80ha and receives runoff from within the development site and from the Wandalup Farms Property to the north. Drainage from within this catchment is generally toward the wetland in the north-eastern corner of the site. Water flows out of this wetland via a stream which leaves the site near the north-eastern corner.

Catchment No. 2 is the largest catchment and is located toward the centre of the site. Surface waters collect in a central depression near the western boundary of Lot 12 and drain westwards off the site in a poorly defined stream that leaves the site at a low point in the ridge that parallels the western boundary within adjacent properties.

Catchment 3 contains a low depression near the centre of the development site. Water flows from the east and north and accumulates in this depression. When the water level is sufficiently high, water from the depression flows through a watercourse (probably man-made) into Catchment Area 1.

Catchments 4 and 5 have little area within the development site, however they are part of larger catchments which extend to the south of the property. Drainage within these catchments is promoted by man-made channels constructed in adjacent farmlands.

The smallest of the catchments is Catchment 6 in the north eastern corner of the site. It is part of a large catchment which extends to the east and northeast of Nambeelup Road. The total area of this catchment is 11.6ha of which free water takes up 5.7ha. This quantity of water is disproportionate to the catchment area indicating that water



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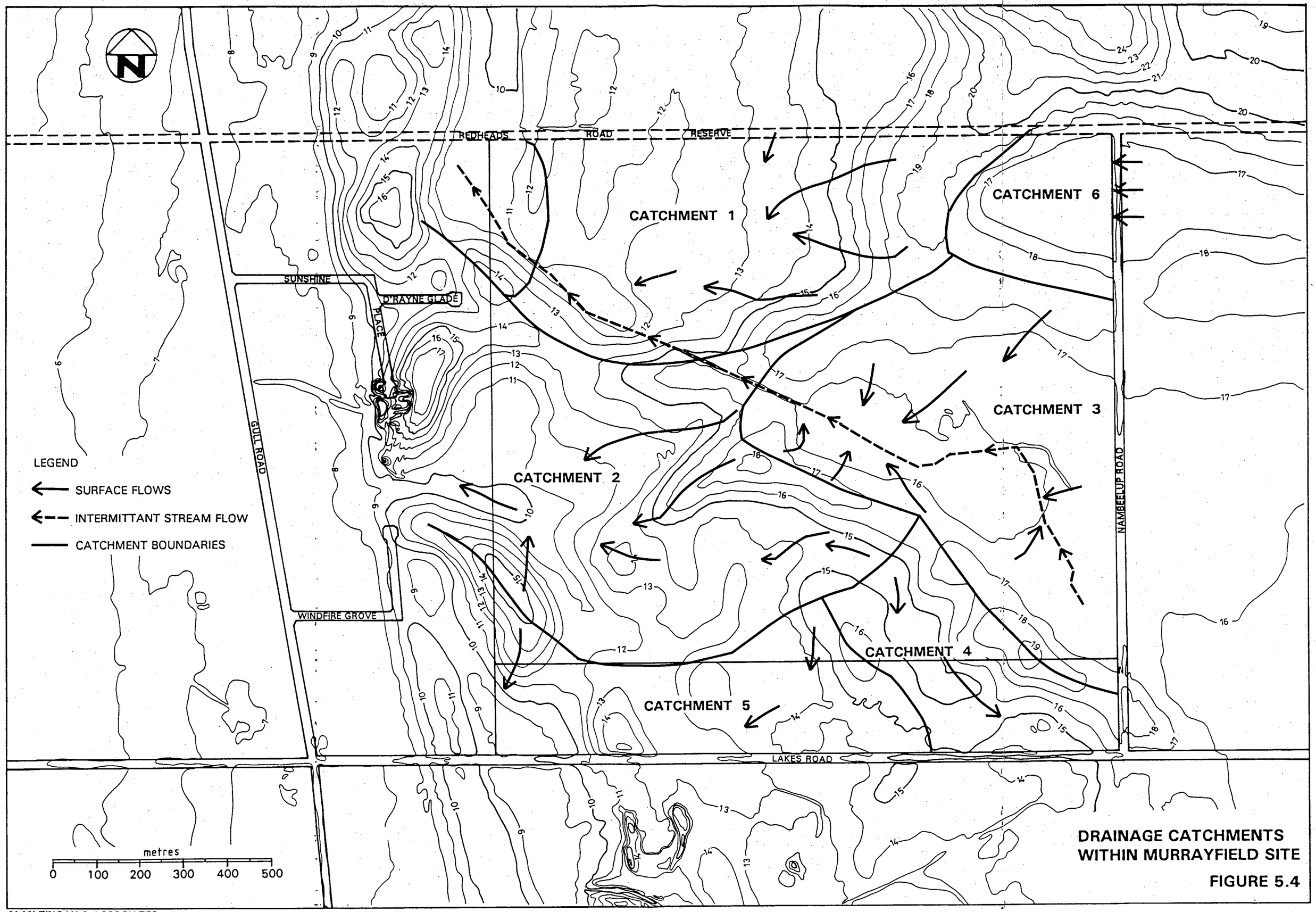
PEEL-HARVEY DRAINAGE CATCHMENT AREA

FIGURE 5.3



DRAINAGE CATCHMENTS WITHIN MURRAYFIELD SITE

FIGURE 5.4

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flows from the east onto the development site. To do this it must flow over Nambeelup Road. When water levels drop, water is retained behind the roadway as a pool.

Ultimately all waters which drain from the site find their way into Nambeelup Brook which is about 1km from the southern border of the site. Waters of the Nambeelup Brook make their way into Goegrup Lake and eventually flow into the Peel Inlet. This has implications with regard to the environmental impact of nutrients exported from the site.

5.2 Biological Environment

5.2.1 Vegetation

Vegetation on the Murrayfield site belongs to the Central and South Bassendean Complex (Department of Conservation & Environment 1980). This complex includes woodlands of Jarrah (*Eucalyptus marginata*), *Allocasuarina fraseriana*, and *Banksia* species on upland sandy soils and *Melaleuca* species and sedgelands on moister sites. These vegetation complexes are common on the Swan Coastal Plain extending from Gnangara in the north to just south of Bunbury.

Upland and lowland vegetation types are found on the Murrayfields site as shown in the vegetation map presented in Figure 5.5.

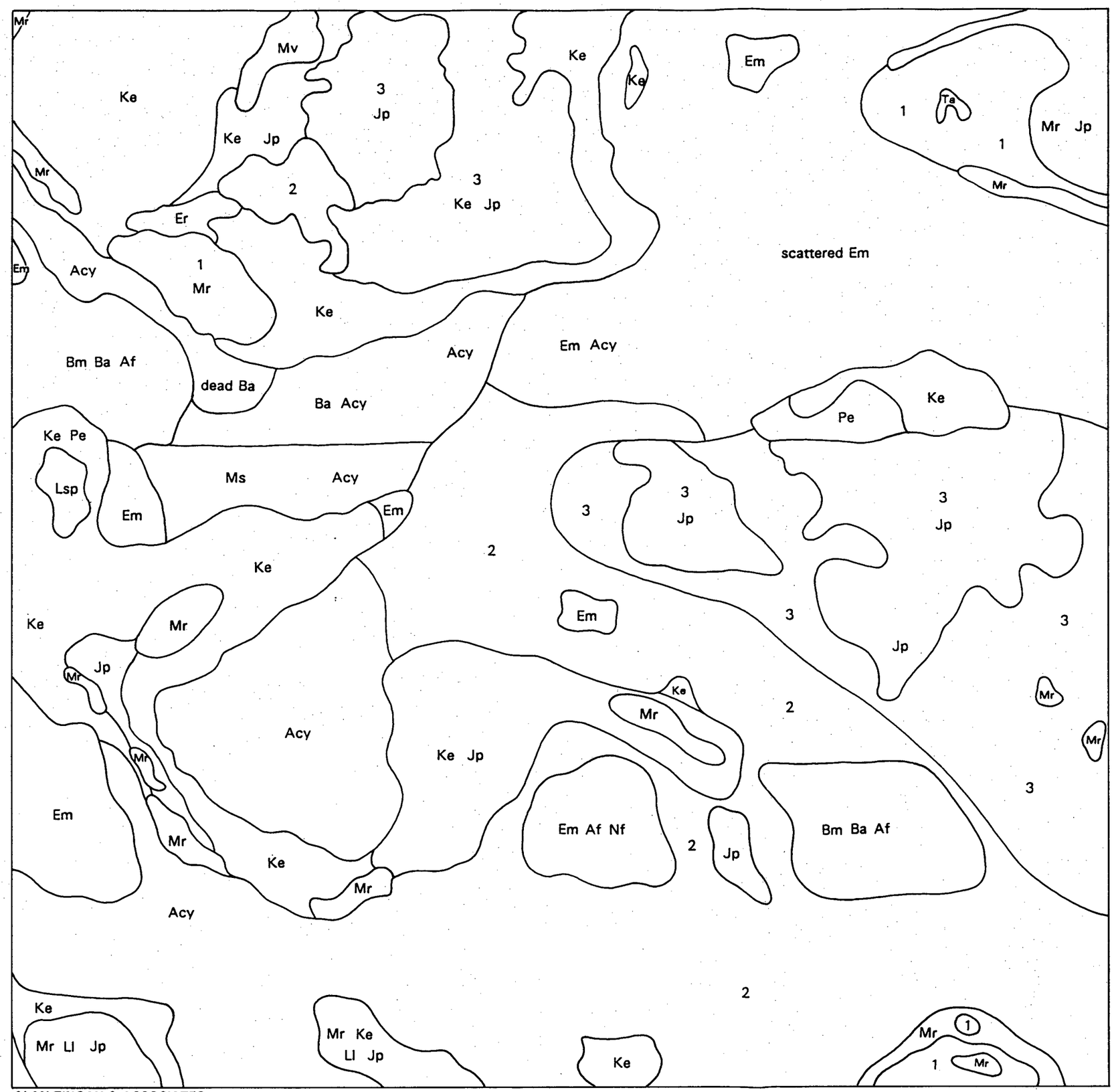
Upland Vegetation

The upland vegetations consist of two types, Banksia Woodland and Jarrah Woodland.

The Jarrah Woodlands have all been heavily disturbed and no good stands remain. The Jarrah understorey has also been totally or partially cleared and contains many weed species. Where the Jarrah trees and other related overstorey species (*Banskia* species and *Xylomelum occidentale*) have been totally cleared, a Shrubland remains in some places. This *Adenanthos cygnorum* Shrubland probably has originated from colonisation by this native species on disturbed sites.

The Banksia Woodland is dominated by *Banksia menziesii* and *B. attenuata* with *Allocasuarina fraseriana* also common. *Banksia ilicifolia* also occurs with some frequency particularly closer to the moister soils in the lower areas. Two main areas of Banksia Woodland remain which are in relatively good condition. One area is in the south eastern section just north of the present runway. Here the understorey contains a species rich shrub layer dominated by *Acacia pulchella, Melaleuca seriata* and *Hibbertia hypericoides*. The introduced weed species *Hypochaeris glabra* and *Ursinia anthemoides* are abundant throughout this pocket of remnant *Banksia* Woodland while around the perimeter, grasses and other pasture species are invading.

The other area of Banksia Woodland in good condition is in the mid-western section. Here the understorey is dominated more by *Melaleuca seriata* while the tree species are in similar proportions to the first area. Other areas of Banksia Woodland have had all



LEGEND

1	Open water
2	Pasture
3	Moist pasture
Acy	*Adenanthos cygnorum*
Af	*Allocasuarina fraseriana*
Ba	*Banksia attenuata*
Bm	*Banksia menziesii*
Em	*Eucalyptus marginata*
Er	*Eucalyptus rudis*
Jp	*Juncus pallidus*
Ke	*Kunzea ericifolia*
Ll	*Lepidosperma longitudinale*
Lsp	*Leptocarpus sp*
Mr	*Melaleuca rhaphiophylla*
Ms	*Melaleuca seriata*
Mv	*Melaleuca viminea*
Nf	*Nuytsia floribunda*
Pe	*Pericalymma ellipticum*
Ta	*Typha angustifolia*

metres

0 50 150 250

N

MURRAYFIELD VEGETATION MAP

FIGURE 5.5

ALAN TINGAY & ASSOCIATES

or most of the trees cut out while the understorey remains as a Shrubland, particularly of *Melaleuca seriatas* and *Adenanthos cygnorum.*

Lowland Vegetation

The vegetation of the lowland areas is determined by the degree of inundation. Much of the lowland vegetation consists of a *Kunzea ericifolia* Scrub or Thicket. Other shrub species common to this vegetation are *Pericalymma ellipticum* and *Astartea fascicularis*. Where the watertable is close to the surface in winter, wetland indicator species occur in the *Kunzea ericifolia* Thickets. *Juncus pallidus, Leptocarpus* sp and *Lepidosperma longitudinale* are three common sedges and rushes of winter-wet habitats. Insectivorous herbs such as *Polypompholyx multifida* and *Drosera* species are common around the edge of these areas.

Much of the area containing *Juncus pallidus* has been intensively grazed and contains introduced pasture species. This is especially true of the broad lowland areas toward the southern boundary, which extends toward the middle and northeastern corner of the site.

Sites with surface water for longer periods during winter and spring are characterised by *Melaleuca rhaphiophylla* Woodland. On the western boundary three small Swamps occur between the road and the present runway. The lowland complex just east of the runway in the northern half contains five small Paperbark Swamps located among more widespread *Kunzea ericifolia* and *Juncus pallidus* vegetation. In the south-eastern corner there is a larger section of Paperbarks both fringing the open water body and in the middle of the much larger wetland which extends into the property on the southern boundary. This wetland is being colonised by the bullrush *Typha angustifolia.*

The largest and best example of a Paperbark Swamp is in the north-eastern section of the property, where an oval-shaped wetland, approximately 2ha in area, is located. This wetland is situated along a drainage line which runs in a north-easterly direction, originating from the large open winter-wet area in the central eastern part of Murrayfields.

5.2.2 Flora

A native plant species list was compiled from collections made in September 1991. Most of the annuals and geophytes which occur at the site would have been collected during this period. However, some earlier and later flowering species may not have been collected. A total of 104 native species were collected, consisting of 1 cycad, 34 monocotyledons, and 69 dicotyledons. This number is low for an area the size of Murrayfield, but reflects the high degree of disturbance which has occurred through clearing, weed invasion and grazing.

Only one species, *Cartonema phylidroides*, is listed as a reserved flora species (Hopper et al, 1990). This is a Priority Three species which indicates it has several poorly known populations with some on conservation lands. Known locations are at Kalbarri, Busselton; and Bullsbrook, Kings Park, Midland, and Padbury in the Perth

Metropolitan Region. Only three plants were observed at Murrayfields within close proximity to each other. They were found on heavily disturbed Banksia-Jarrah Woodland sands in the north eastern quarter of the property. They do not occur in any of the good quality vegetation stands, and are therefore under intense pressure from grazing and vehicle disturbance.

5.2.3 Fauna

A desk study was carried out to assess whether any rare and endangered species of fauna could possibly inhabit the site. It was concluded that this is unlikely given the general absence of such species in the region and the large degree of clearing over the site. Much of this fauna will be restricted to wetlands and associated dense vegetation.

A list of both waterbirds and bush birds expected to be found on the Murrayfield property was compiled after consulting the Royal Australian Ornothologists Union database. Little, if any, breeding by waterbirds is anticipated to take place on the property as the waterbodies are small and ephemeral and there are a number of large and more permanent wetlands nearby. It is not expected that water birds would use the area as a drought refuge since the wetlands dry out in summer.

Some small native mammals could be present on the property but this seems unlikely. It is anticipated that *Orcytolagus cuniculus* (rabbits) and *Vulpes vulpes* (foxes) occupy the area. The Western Grey Kangaroo (*Macropus fuliginosus*) range over the area but in low numbers.

5.3 Sociological Environment

5.3.1 Population Characteristics

In 1986, the estimated resident population of the Peel Region was 29,672 (ABS Census Data). The Town of Mandurah, contained the greater proportion of this population (19,196 people). Almost 90% of the Peel Region's population growth between 1981 and 1986 occurred in Mandurah, and it is expected that this trend will continue. Areas such as Murray Shire, in proximity to Mandurah, will provide for most of the balance of the anticipated population growth.

Population projections for the region, as discussed in the Peel Regional Planning Study, indicate that regional population could increase to a figure between 65,000 and 70,000 by year 2001, and to a figure between 83,000 and 90,000 by year 2011.

Examination of the age characteristics of the region's population indicate that in 1986, the Shire of Mandurah had almost 37% of its population aged 55 and over, compared to a State figure of 17.4%. Mandurah's recognised past status as a major retirement area accounts for this difference, however the percentage of persons over 55 years of age is expected to fall over the next decade, with a corresponding increase in the young and middle aged groups.

It is expected that the Peel Region will experience quite considerable population growth over the ensuing two decades, with Mandurah and contiguous areas providing for the bulk of this growth. Future growth in urban areas will mostly be close to the coast well away from the development site. A land holding called Armarillo, well north of the development site, may possibly be developed as a residential estate within a medium to long term time frame. At the time of writing there were no definite proposals to develop this land.

5.3.2 Tourism

The Peel region is one of the State's most popular tourist destinations. Proximity to the beaches and coastal foreshore areas, to the Peel Inlet, and to the forests of the Darling Range, together with the Town of Mandurah as a centre for leisure activity, provides a sound basis for further recreational development in the Region.

Total arrivals for accommodation purposes increased by 50% between 1983 and 1987 (Peel Regional Planning Study) and increased opportunities for growth in visitor and leisure activities have been identified as important to the District and Regional economy.

5.3.3 Employment

At June 1990, it was estimated that the unemployment rate for the Peel Region stood at 10.4% for the total urban force of 17,427, with Mandurah at 12.8%, significantly higher. This compares with the State unemployment rate of 7.6%. Analysis of unemployment figures show that employment opportunities for persons in the age groups between 15 and 30 years, will be needed. With growth in population expected in the Peel Region over the next two decades it can be clearly seen that employment opportunities, particularly in Mandurah and contiguous areas, will become increasingly important.

5.3.4 Archaeology and Ethnography

An Aboriginal site survey of the study area was carried out to determine if there is potential to interfere with any significant aboriginal sites. The report on the survey is presented in Appendix 3.

The archaeological survey strategy involved an investigation of previous research in the area, a systematic field survey consisting of a series of transects spaced 50 metres apart, as well as predictive sampling of selected areas and the recording of any archaeological material located.

Whilst theoretically the area offered high potential for the location of Aboriginal sites, the fact that much of the land mass was inundated with water reduced its potential. Nevertheless the potential for isolated artefacts as a result of sporadic hunting and food gathering activities was considered high.

No archaeological sites were located in the field survey. Therefore the issue of significance does not arise. Two isolated artefacts were located in the southern sector of the project area. The isolated finds are consistent with artefact assemblages that have been previously recorded in the region. It is concluded that there are no constraints for the development with regard to archaeological sites. However, if any sites are subsequently found, the developers are obliged to report them as outlined in the Aboriginal Heritage Act 1972-1980.

An ethnographic study was performed to determine if there were any ethnographic sites within the development site that could be disturbed by the construction of the Murrayfield Aerodrome. The results of this study are presented in full in Appendix 4.

Aboriginal people who have a history within the region were interviewed and visited the site. No sites of significance to living Aboriginal people were identified and none had been previously recorded. It is the conclusion of the study that no sites of significance will be affected by the proposed development.

5.3.5 Existing Noise Levels

The level of noise generated by activities associated with neighbouring land use activities was measured as part of a noise assessment performed on the site. The adjacent kennel zones and piggery (Figure 5.6) have the potential to generate noise that could annoy users of the resort. However, measurements taken on the site did not detect noise coming from either of these sources.

5.3.6 Access

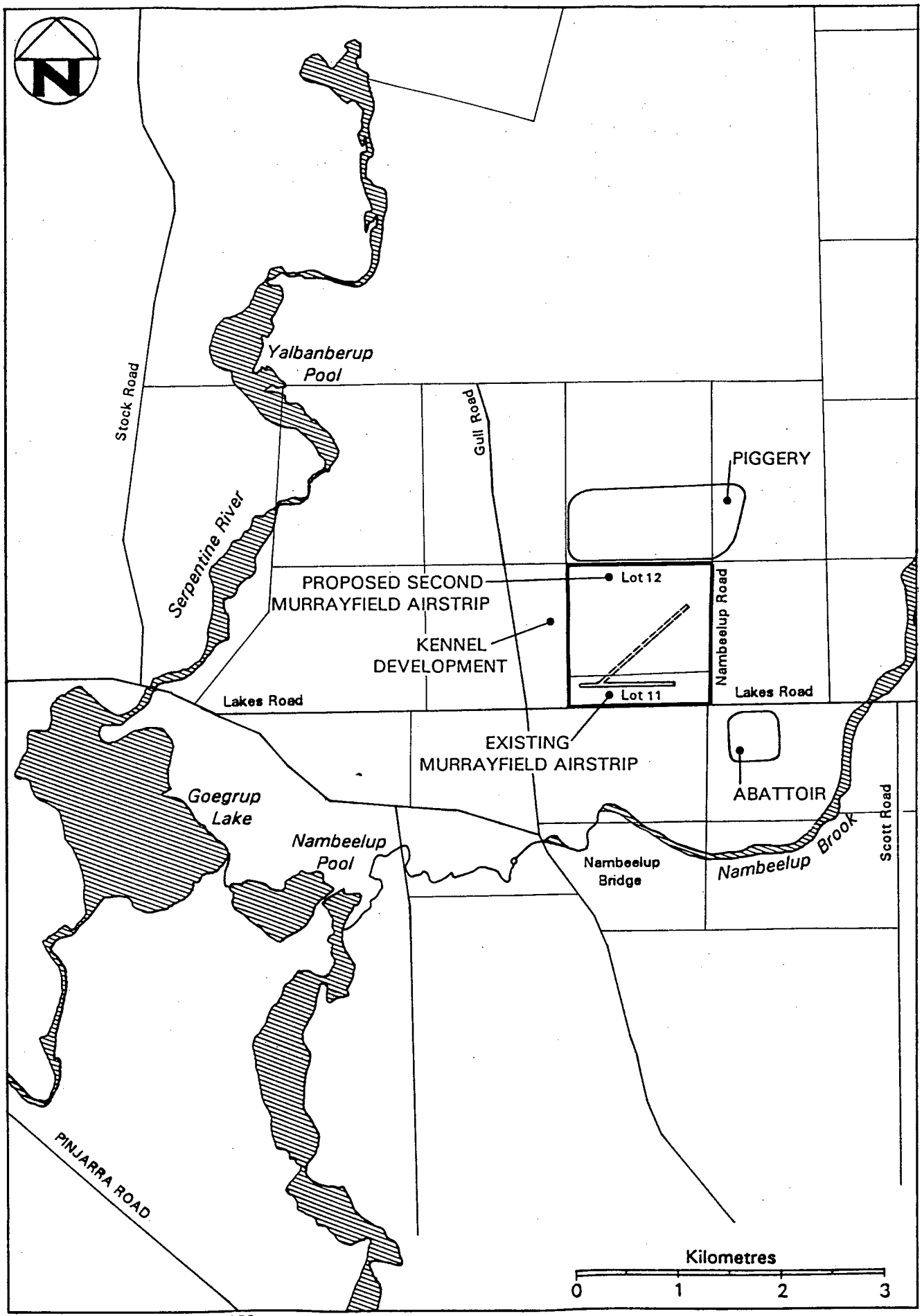
The Murrayfield Airpark is located on Lakes Road, a relatively well used road which at present links Mandurah with the South Western Highway at North Dandalup, thus providing ready access from both of the major south-west traffic routes. Access points to the site will be from Nambeelup Road which runs off Lakes Road and from Lakes Road itself. Both these roads are sealed formations with gravel shoulders.

In the longer term, an extension of the Kwinana Freeway and the Perth-Bunbury Highway will eventually give rapid access to within 1.5km of the Airpark.

5.3.7 Existing Land Use

The development site has been used for agricultural purposes for many years. The site is currently used for cattle grazing with cattle feeding on introduced pasture species and the regrowth of native vegetation. A number of dams have been dug over the site to provide water to stock during the hot, dry summer months. These dams are essentially interceptions of the shallow groundwater table.

A single runway together with support facilities such as hangers and clubrooms have been constructed on Lot 11. These have been in regular use since their construction and are operated by Hawkview Pty Ltd. The Royal Aero Club currently uses the site



ALAN TINGAY & ASSOCIATES

ADJACENT LAND USE

FIGURE 5.6

for the training of student pilots on most week days and for use by its members generally.

5.3.8 Adjacent Land Use

The majority of land surrounding the development property is agricultural and is used to raise cattle or grow fodder crops. Land on the western border has been subdivided into 2ha lots for use as dog kennels. These lots are either vacant or have residences constructed on them.

An abattoir, which at the time of writing was not in operation, is located near the south east corner of the site and a large commercial piggery occupies neighbouring land to the north (see Figure 5.5). The remaining surrounding land is used for agricultural purposes or is uncleared.

5.4 The Peel-Harvey Estuary System

5.4.1 Background

The Peel-Harvey Estuary System is an expansive shallow lagoon into which the Serpentine, Murray, and Harvey Rivers drain (Figure 5.3). This estuary system has become eutrophic as a result of the influx of nutrients, particularly phosphorus, from its catchment of some 2200km^2 of the Swan Coastal Plain. The estuary's shallowness, extensive surface area, and low flushing rate to the ocean has compounded the problem associated with eutrophication.

Much of the catchment of the Peel-Harvey Estuary is composed of land used for agricultural purposes that has poor quality soils lacking in nutrients. As a result superphosphate fertiliser is applied to the land to promote pasture growth. Typically the land has been cleared of much of its natural vegetation.

Nutrient inputs from agricultural lands in the catchment have been identified as the cause of eutrophication in the Peel-Harvey Estuary System (Department of Conservation and Environment, 1980). A symptom of this condition is the excessive growth of algae in the estuary. Problems related to this excessive growth have been reported from as early as 1960 and have included the fouling of beaches, the clogging of fishing nets and the creation of offensive odours from the decay of algae. There is a real risk that rotting algae may lead to the collapse of biological systems in the estuary with associated large scale mortality of fish and crustaceans.

It has been calculated that the estuary is receiving approximately 70% more phosphorus on a yearly basis than it can assimilate (Kinhill Engineers Pty Ltd, 1988). This phosphorus is being transported through drains, watercourses, and groundwater from farmlands where the application of phosphorus fertilisers has been excessive. In addition, clearing has promoted the transport of nutrients by increasing runoff and decreasing the vegetation that is able to uptake nutrients.

5.4.2 Nutrient Management

The State Government has investigated methodologies by which the eutrophication problems experienced by the Peel-Harvey Estuary can be managed. These management strategies are detailed in Stage II, Peel-Harvey Environmental Review and Management Program (Kinhill Engineers, 1988) and in the subsequent EPA assessment report (EPA, 1988).

The management strategy has two basic aims;

i) to reduce the influx of nutrients into the estuary by effective management in the catchment, and

ii) to increase the export of nutrients out of the estuary by increasing flushing to the ocean.

Management in the catchment includes the promotion of tree planting, reduction in the use of fertilisers and a moratorium on clearing. It is also proposed that a channel be cut from the estuary to the ocean at Dawesville to promote flushing of nutrients from estuary.

6. ASSESSMENT OF ENVIRONMENTAL IMPACTS

6.1 General

The proponent has endeavoured to minimise the potential environmental impacts posed by the project by taking into acount the natural features of the site and the constraints that apply to development within the catchment of the Peel-Harvey Estuary. Regard has been given to the sociological impacts that could affect nearby residents as a result of the operation of the aerodrome. It has been the proponent's aim to minimise these impacts by the inclusion of appropriate design features into the development and the adoption of special policies regarding its operation. The following sections describe the potential impacts that could result from the development. The management and monitoring of these potential impacts is described in Section 7.

6.2 Noise

6.2.1 Introduction

A study was performed to assess the acoustic impact of the proposed Murrayfield Airpark on areas surrounding the development site. This study considers the impact of noise generated by the construction of the Airpark, and the Airparks operations. It also considers the impact of surrounding industry on the resort. The report is presented in full in Appendix 4.

Part of the study involved recording existing sound levels on the site to assess the ambient noise conditions generated by existing aircraft, traffic and industry. Noise producing elements that would be introduced to the site as a result of the development were then considered. This involved calculating the noise they would produce and assessing this against recorded background noise levels and guidelines set out by the Environmental Protection Authority pertaining to noise pollution. Fixed wing aircraft noise was assessed using Federal criteria that consider the annoyance of sound produced at an aerodrome based on the type of aircraft that uses the facility and flight frequency of aircraft. These guidelines and criteria, are discussed fully in Appendix 4.

6.2.2 Fixed Wing Aircraft

The study found that unacceptable noise levels would be generated over some residential lots immediately to the west of the existing runway which runs east-west. However, this is an existing situation as at present the east-west runway in the only operational runway and thus is used by all air traffic. All other areas that would be affected by noise generated by fixed wing aircraft are non residential or within the development itself and thus do not present a problem.

6.2.3 Helicopters

It is proposed that a helicopter landing area be provided as part of the flying facilities offered by the Airpark. This will be located toward the eastern boundary of the site (Figure 4.1).

A "noise footprint" will be generated by the operation of helicopters. This noise footprint is mostly within the confines of the Airpark, however, a portion does extend into adjacent rural land. There are no existing residences in the affected area and thus no noise impact is expected.

6.2.4 General Operations

It is unlikely the activities associated with golf course maintenance, aircraft workshops, and mechanical services plant, will unduly effect residences with regard to noise. This conclusion is based on the assumption that maintenance activities will be performed during normal working hours, that workshops will be enclosed, and that small pieces of equipment such as air conditioning plants and generators are suitably engineered.

Special attention has been given to the potential impact from the testing of aircraft engines after servicing. Predictions show that unacceptable levels of noise would be experienced in the adjacent residential areas to the west and in rural areas to the east. This noise is likely to be particularly annoying due to frequency modulation and tonal components. As a result the testing of engines will have to be carried out in purpose built enclosures to reduce noise levels to acceptable levels.

6.3 Nutrients

6.3.1 Current Nutrient Inputs

About 60%, or 114ha, of the land to be developed is currently used for the grazing of cattle. To improve the pasture, the property is fertilised on a yearly basis at a rate of 125kg of superphosphate per hectare. Superphosphate has a phosphorus content of approximately 8.3% and therefore about 10.37kg of phosphorus is applied per hectare on a yearly basis. This is about 10% greater than the Department of Agricultures recommended fertiliser application rate for rain fed pasture of 9kg per hectare.

The actual usage on the property suggests that a total of about 1180kg of phosphorus is applied to the site on a yearly basis.

6.3.2 Nutrients Inputs from the Development

Fertilisers will be used to establish and maintain the golf course greens, tees and fairways and small grassed areas within the resort complex. There will also be inputs from the treated effluent that will be used to irrigate the aerodromes grassed runway.

It is envisaged that 13ha within the golf course will be grassed together with an additional 5ha within the resort complex. The expected phosphorus loadings on the 9 hole golf course have been calculated using fertiliser application recommendations provided by manufacturers. These are as follows:

- 200 kg/ha of super Cu, Zn, Mo fertiliser containing 8.3% phosphorus prior to seeding.
- 200 kg/ha of fertiliser containing 2% phosphorus each quarter of the first year following seeding.
- 1800 kg/ha of fertiliser containing 2% phosphorus for greens (3ha) and 900 kg/ha of the same fertiliser for fairways and other grassed areas (15 ha) annually.

The above figures are considered to be the maximum quantities that will be applied as soil amendments will enhance nutrient retention in the soil.

An additional 60kg of phosphorus will be applied to the grassed runway in the form of treated effluent. This figure represents about 60% of the potential uptake of phosphorus by irrigated grass over 5.4 ha. No other fertiliser will be applied to the grassed runway.

The maximum phosphorus loadings are presented in Table 6.1 together with the loadings currently applied to promote pasture growth on the property for grazing. The figures given are based on the assumption that the first application and the subsequent quarterly applications will all be applied in the first year.

TABLE 6.1

Comparative Phosphorus Loadings for the site

Current	1st Year	2nd Year	3rd Year
1180 kg	584 kg	408 kg	408 kg

6.3.3 Net Nutrient Impact

There will be a net reduction in the amount of nutrients applied to the site as a result of the development proceeding. A comparison between the current application rate of fertiliser and that which would occur as a result of the development is shown in Table 6.1. It can be seen that in the first year there will be about a 50% decrease in the quantity of phosphorus applied to the site and thereafter a 65% reduction annually. The impact of fertiliser application on surface and groundwater quality will be reduced even more substantially than this figure suggests as a result of management practices to control the export of phosphorus from from the site (see Section 7.1).

6.4 Groundwater Extraction

It is proposed that groundwater for irrigation and drinking water purposes be drawn from bores sunk into either the Bassendean Sands or the Leederville Formation.

Wetlands on the site are surface-water expressions of the unconfined aquifer in the Bassendean Sand and there is a potential for groundwater extraction to reduce groundwater flow to the wetlands. In considering this factor it should be remembered that these wetlands are ephemeral and are naturally dry in summer months.

A mathematical equation (the Theis equation) is used to estimate drawdowns in the groundwater table that could result from the pumping of a bore. In calculating the drawdown it has been assumed that the bore will be pumped at a rate of $500m^3$/ a day. The estimated drawdowns in the water table are presented in Table 6.2. From these figures it can be concluded that pumping a bore near the centre of the property would have little effect on the wetlands within the site.

TABLE 6.2

Estimated Drawdowns Around Bassendean Sand Bore.

Distance (m)	Drawdown (M)
5	2.0
100	0.8
500	0.2
1000	0.04
2000	0.02

Water extraction from the Leederville Formation has little potential for impact on wetlands within the site. However, there is the potential to influence the performance of nearby bores drawing from the Leederville Formation. Calculation of the draw down from a bore sunk in the middle of the site has showed that it would not be of sufficient size to influence the nearest bore on an adjacent farmland property. Further details on potential drawdown effects are given in Appendix 2. There are no groundwater protection areas within the immediate vicinity of the development.

6.5 Biological Impacts

6.5.1 Vegetation

The proponent is aware of the moritorium on clearing within the Peel-Harvey catchment and has endeavoured to keep the removal of vegetation on the site to a minimum. It is the proponents intention to plant indigenous trees and shrubs throughout the development and especially within the golf course. This should compensate for the vegetation that will be cleared.

The majority of the development site has been cleared of woodland species such as Jarrah and Banksia to facilitate grazing. Much of the remaining vegetation over the site is regrowth or remnant low shrub. Two good woodland stands exist on the site, one stand of Banksia toward the south eastern corner and one near the north western corner on the western boundary. These will be retained and enhanced by plantings. Other stands of vegetation are of poor quality and will be cleared where required. Where practical, vegetation (especially tall trees) will be retained to enhance the attractiveness of the Airpark.

6.5.2 Wetlands

The retention of wetlands within the development site has been a priority in the design of the aerodrome and resort. As a result the vast majority will be retained and incorporated into the landscaping of the development. This will serve to conserve and protect them and at the same time enhance the attractiveness of the development.

There are a number of seasonally inundated areas within the Murrayfield site. These are mostly poorly defined stream courses and broad depressions that are the product of the low lying topography of the Bassendean Dunes and the relatively shallow groundwater table. These physical features are common in the Murray Region (Wells 1989) and they result in an abundance of seasonally inundated areas throughout the Shire of Murray. Similar seasonally inundated areas are found in the majority of properties surrounding the development site.

There are four small areas of seasonally inundated land that contain sparse Melaleuca Woodland that cannot be avoided by the development. Three of these occur near the south western corner of the site just north of the existing runway and the other toward the middle of the site. There is also a broad depression that contains scattered rush and sedge but no Melaleuca and is used as pasture. All of the above are in an area required for the construction of the major runway and the adjacent grassed runway. The location of the runway is based on the prevailing wind patterns of the area, the need to ensure the safety of flyers by maintaining obstacle free take off and approach areas, and constraints relating to noise and nearby residents. As a result there is little flexibility in the location of the runways and thus these seasonally wet areas cannot be retained within the proposed development.

The wetlands in the path of the runways have been classified using EPA Bulletin 374 to help assess the acceptability of the environmental impact posed by the construction of the runways. In assigning a classification to a wetland the Bulletin takes into account such factors as uniqueness, quality and extent of vegetation, and human usage. The results of the classification are presented in detail in Appendix 6. Only those wetlands that will be impacted upon have been classified, all others are to be retained and their quality enhanced thus classification was not necessary. It is important to note that the preserved wetlands are the largest in area and have the best quality vegetation.

The wetlands in the pathway are, according to EPA Bulletin 374, Category M or multiple use wetlands. These wetlands are described as being significantly degraded, possessing few natural attributes and limited human use interest. On this basis the

environmental impact of removing these wetlands is considered to be acceptable. The proponent plans to construct a number of artificial wetlands within the golf course which will be planted with native species. This will help offset the negative impacts of removing the wetlands as others will be created.

There has been a degree of flexibility in the laying out of the golf course that has allowed the avoidance of wetlands. However, a number of holes will need to be constructed on a low lying area that is poorly drained near the middle of the northern boundary. This area contains sedges and rushes but has also been used as a summer pasture classification of this area using Bulletin 374 showed it to be a Category M wetland (Appendix 6). As such the construction of golf holes is not considered to pose an unacceptable environmental impact. It is in this location that the artificial wetlands will be created. This will be done by excavating to below the lowest groundwater table to ensure that they will contain water all year round unlike the natural wetlands on the site.

6.6 Sociological Impacts

6.6.1 Economic Benefits

The construction and operation of the Murrayfield Airpark will provide employment for a substantial number of people within the Mandurah-Murray Region. Construction phases of the airpark are expected to employ some 80 persons, whilst subsequent operational phases of the aerodrome and resort will provide long term employment in a wide range of occupations to the extent of some 150 persons full time, with part time employment for a further 150. Multiplier effects will further increase local employment. It is expected that a large proportion of the jobs offered by the Airpark will be suitable for people in the 15 to 30 years age group, thus having a positive impact on the employment prospects of a group which currently suffers high unemployment within the region (see Section 5.3.3).

6.6.2 Tourism and Recreation

The airpark proposal will add a new dimension to the Region's tourist and recreation potential, and materially assist growth by:

- providing resort accommodation for local aviators who wish to enjoy the air-related activities offered as a holiday destination;
- attracting interstate and overseas groups to specialised facilities offered;
- promotion of special events and aircraft oriented activities structured around:

  Flying Events
  Carnivals
  Air Shows
  Conventions

Interclub Activities

The airpark will eventually be linked to similar projects located around Australia, and to other aero clubs. Club members will be actively encouraged to fly to other airparks and thus promote return visits. It is expected that the airpark will achieve high occupancy levels from local membership, and other visitors from interstate.

Visitors attracted to the facility will inevitably spend money within the region and therefore assist in the success of local businesses and in turn enhance the employment prospects of the population.

6.6.3 Landscape Aesthetics

It is the aim of the promoters of the Murrayfield project to provide a pleasant setting for the resort complex and aerodrome. As a result native trees and shrubs will be planted intensively around the property to provide wind breaks, shade and privacy except where they may pose an obstruction to low flying aircraft.

The highest building within the resort complex will be a central two storey building which will house the convention facilities, restaurants and administration. Given the low height of the buildings and the dense plantings around the boundary it is expected that little of the facilities will be visible from roads running past the property.

6.6.4 Roads

Generally the development will result in further usage of Lakes Road which is a major east-west road that currently experiences moderate use. As visitors will spend most of their time within the resort complex the majority of any increase in traffic will be from employees going to and from work and visiting service vehicles. It is considered that existing road networks will be able to handle this increase in traffic load adequately.

6.6.5 Construction Phase Impacts

Dust

EPA guidelines have been used to assess the potential of construction to inconvenience neighbours due to dust generation. These guidelines take into account factors such as the nuisance potential of soils when disturbed, the total area of disturbance, the type of work that is to be performed and the distance to improvements from the construction.

It was determined that there will be a negligible risk of dust generation disturbing neighbouring landowners. This is mostly because the nearest improvements are a long distance from the construction area. The risk is further reduced by the fact that major earthmoving activities which have the greatest potential to generate dust will be performed in winter. Despite the above, the proponent is prepared to be ready to control the generation of dust if it poses an inconvenience to neighbours.

Noise

Modelling has been used to predict the noise generated by earth moving equipment that would operate on the site. These calculations are based on the simultaneous operation of 2 scrapers, 3 trucks, a bulldozer, a grader and a front end loader.

Predictions indicate that noise levels of up to 50 dB(A) will occur due to construction activity at the south western end of the proposed runway. These levels would also have a tonal component that would add to annoyance levels. However, the noise levels that would be experienced by residents are within the acceptable range.

6.6.6 Nuisance Insects

A significant proportion of the development site is low lying and poorly drained. Consequently there is an abundance of free standing water that can provide breeding sites for mosquitoes (*Culucidae*) and midges (*Chironomidae*). Some species of these insects have the potential to transmit disease and can be of general nuisance if in high enough numbers.

It is considered that the Aerodrome development will result in a net reduction in the area of free standing water available for the breeding of nuisance insects. As a result there should be a net reduction, however small, in the number of nuisance insects breeding within the development site.

Existing levels of nuisance insects may be of a sufficient level to inconvenience people utilising the aerodrome facilities thus control measures may be warranted. Advice will be sought from Health officers within the Shire of Murray and the Health Department of Western Australia regarding approved methods for dealing with this problem if necessary.

6.6.7 Odour from Piggery

During visits to the site no odour was detected originating from the piggery. This was despite the fact that light winds from the north east were blowing over the Murrayfield site and that these winds would have carried any offensive odours from the piggery. Stronger winds such as south westerly's which are common in the area would disperse odours far more effectively than the light south easterly. As a result it is not expected that the operation of the piggery will adversely affect the resort.

6.6.8 Noise from Piggery and Kennels

Measurements taken on the development site indicate that residents and visitors will not experience unacceptable levels of noise from the adjacent dog kennel area or piggery.

6.7 Public Participation and Consultation

The Royal Aero club conducted a survey of the attitudes and concerns of nearby residents with regard to the proposed expansion of the aerodrome complex. This was done to ensure that residents had an opportunity to raise issues so that they could be adequately addressed in the planning stages of the development. The full study and its results are presented in Appendix 5.

Landowners that had established or were in the process of establishing a residence within 3km of the development site were visited by members of the clubs executive committee. The aerodrome was discussed in full including details of its operation. The residents were then asked if they had any concerns or questions regarding the development. These were answered by the executive members and arrangements were made for further meetings where appropriate. Where issues of concern were identified liaison on a personal basis were maintained.

Below is a list of issues that were raised during the meetings with residents. Beneath each issue is the relevant section within this document that provides information on the subject of the query from the resident.

- The effect of the rezoning of Nambeelup Park zoning for kennels.
  Frequency: 1 (Appendix 5)

- The operations of the airfield from a safety aspect.
  Frequency: 3 (Section 1.7 and Appendix 5)

- Access by local residents to resort facilities.
  Frequency: 2 (Section 4.3.1)

- Boundary fence re-alignment.
  Frequency: 2 (Appendix 5)

- Plans for drainage of run-off flood water.
  Frequency: 1 (Section 4.2.4)

- Pilot responsibilities operating from the Airfield.
  Frequency: 3 (Appendix 5)

- Training student pilots:
  Frequency: 3 (Appendix 5)

- The advent of jet airliners.
  Frequency: 1 (Sections 4.2.1)

- Compatibility of the piggery and proposed resort.
  Frequency: 1 (Sections 5.3.5 and 6.6.7)

Generally there was a favourable response to the proposed development. All persons indicated that they were aware of the existing airfield operations and that they had not experienced any difficulties with it.

One resident interviewed was against the proposal proceeding, however, no relevant reasons for objecting were given. An issue commonly raised was that of safety at the aerodrome, but once safety measures were explained residents generally became satisfied. The individual issues raised are discussed more fully in Appendix 5.

It was the conclusion of the study that owners and residents within the study area, with one exception, saw the development in a favourable light. The Royal Aero Club will continue to liaise with residents in to the future to ensure that areas of concern are addressed as they arise.

7. ENVIRONMENTAL MANAGEMENT

7.1 Nutrients

7.1.1 Regional Nutrient Management Strategies

An Environmental Protection Policy for Phosphorus Management in the Coastal Catchment of the Peel-Harvey Estuarine System (1990) has been prepared for the EPA by the Department of Agriculture. At the time of writing this had been prepared to a draft policy stage. The draft policy sets a number of management targets with regard to phosphorus loadings within the Peel-Harvey Estuarine System and allocates annual phosphorus loadings to the major watercourses which flow into the estuarine system.

The policy presents a number of principles relating to land use within the catchment of the Peel-Harvey that will be used to meet management targets. Two of these are directly applicable to the proposed Murrayfield Airfpark development. These are;

- that management targets shall be achieved through the reductions of phosphorus from both point and non-point sources, and

- through application of land use planning and development controls, phosphorus exports to waterways shall not exceed 0.4kg/ha/annum.

In the following sections it will be shown that the proposed development conforms with these principles.

7.1.2 On-site Nutrient Management Strategies

The aims of the nutrient management program will be to minimise the overall phosphate requirements of the site and reduce the amount of phosphate to be exported. Efforts to achieve this will be concentrated on the immediate confines of the area which will receive fertiliser. This will be achieved by modifying soils beneath more intensely fertilised areas, selecting species of turf with low nutrient requirements, adopting fertilisation strategies that will limit the export of nutrients in surface and groundwaters, and monitoring nutrient levels in soil and water with the view to amending fertiliser strategies. It will be the responsibility of the Resort Manager to implement the nutrient management program for the golf course.

An analysis of nutrient loadings prior to and after development has shown that there will be a 65% reduction in the quantity of phosphorus applied to the site as a result of the development (Section 6.3.3). Further cuts in fertiliser application may be achievable depending on the success of nutrient management techniques.

Soil Modification

Bassendean Sands generally have poor nutrient retention capabilities and as such the nutrients contained in fertilisers have the potential to be quickly leached before being utilised by the turf to which it is applied. To prevent this the proponent is willing to

commit to modifying the soil beneath areas which will receive fertiliser. These areas include all tees and greens within the golf course and all lawns within the resort complex.

It is proposed that red mud will be imported to modify the soils beneath the fertilised areas. Red mud has the ability to sequester phosphate dissolved in water and fix it into its chemical structure thereby preventing it from migrating into the groundwater beneath the site. Liaison with relevant authorities and institutions will be made to ensure that the appropriate quantity of red mud is mixed with the soil. Modification will also enhance the ability of the soil to retain water.

Fertiliser Application Strategies

Details on the rates of fertiliser application on a yearly basis are given in Section 6.3.2. The general principle for fertiliser application after establishment will be a little, often. This will ensure that there is a minimal amount of excessive fertiliser that is available to be leached away. Alternatively a larger quantity of slow release fertilizer will be applied less frequently. Fertiliser application will also be timed to avoid periods when high runoff producing rain events have a high probability of occurring.

Periodic analyses will be performed on modified soils to determine their nutrient content and nutrient fixing ability. This information will be used to fine tune the fertiliser application rate.

Turf Species

The selection of grass species for the golf course has yet to be made, however, selection will be, amongst other factors, based on relative nutrient requirements. The grass species Kikuyu (*Pennisetum clandestinium*) is favoured for broad-acre areas such as fairways because of its vigorous growth, non-dormancy in winter, and low nutrient requirements compared to other turfs (del Marco, 1990).

7.2 Surface-Water Quality

7.2.1 Wetland Water Quality

Studies have been performed on the water quality of wetlands that are relatively close to those on the Murrayfield site (Wrigley et al, 1988). It is considered that their condition will approximate the quality of water within the Murrayfield wetlands. These surface-waters were found to have relatively high phosphorus concentrations which were attributed to agricultural activity in the area. They were also stained with organic matter which had been leached from the sandy soils of the Bassendean Sands. This same heavy staining has been observed in the Murrayfield wetlands.

It is considered that there will be a general improvement in the quality of water in wetlands with regard to nutrients because of the reduction in fertiliser application over the development site.

Central to water quality management is the fact that surface flows from the development will not reach wetlands. The permeability of Bassendean Sands (Section 5.1.4) will ensure that waters which drain off the more elevated development areas will percolate into the ground. There will be no piped or culverted flows of water from development areas into low lying areas that conduct water to wetlands on the property.

Strategies have been put in place to ensure that waters which flow from development areas do not contain contaminants which may have a negative impact on the quality of surface-waters. These are presented in Table 7.1 and include management strategies aimed at reducing the potential for phosphorus to leach into groundwaters.

7.2.2 Artificial Wetlands

A number of artificial wetlands will be constructed within the golf course area for aesthetic reasons. These will probably be in areas that are low lying and thus will intercept the groundwater table all year round, however they will not receive any drainage waters from development areas. Water quality within these artificial ponds will be a reflection of the quality of groundwaters. Measures put in place to protect the quality of groundwaters will consequently protect the quality of waters in these ponds.

7.2.3 Monitoring

The quality of surface-waters will be assessed by regular analysis of waters from wetlands. The program will concentrate on nutrient levels within surface-waters. If nutrient levels continue to be high in these water bodies modifications to fertiliser application strategies will be considered.

7.3 Groundwater

A groundwater monitoring program will be a requirement of the granting of a Well Licence for any bore sunk on the site to provide water for irrigation and general purposes. It is proposed that the monitoring program will have the following components:

- recording of the weekly pumpage using a water meter,
- water levels in production bores, wetlands, and piezometers installed alongside selected wetlands to be measured and results correlated with bore operation,
- measurement of electrical conductivity, temperature and pH of bore water weekly, and
- analysis of bore water and wetland water every three months for concentration of major ions, total nitrogen and total phosphorus.

7.4 Noise

7.4.1 Construction Phase

Modelling has shown that the noise generated by construction will be within acceptable levels (Appendix 4). This is dependent on construction being restricted to day light hours Monday to Saturday inclusive, which the proponent is willing to commit to.

7.4.2 Operational Phase

Fixed Wing Aircraft

It has been established that unacceptable noise levels would be generated over the residents directly west of the east-west runway. The runway is currently being actively used by Hawkview Pty Ltd thus this situation already exists. No other residents will experience unacceptable levels of noise from the operation of the aerodrome.

The construction of a second runway offers the opportunity to lessen the present impact on residents west of the east-west runway by offering an alternative runway that does not fly over residential areas. If a policy of priority use of the second runway were to be established noise levels would be reduced over the area currently being impacted upon. A study of yearly wind strengths and distributions has shown that the east-west runway would only have to be used 12% of the time. As a result there would still be some impact, however noise levels would be less than the current situation and therefore acceptable.

Other areas outside the aerodrome would experience unacceptable levels of noise if they were to contain residences. Currently they are zoned rural and it is recommended that this zoning be retained. No residential developments in the foreseeable future are expected near the development site.

Engine Testing

Aircraft engines need to be run for a set period on the ground as a test after servicing. Modelling has shown that if this was carried out in the open nearby residents would experience unacceptable levels of noise. As a result testing will need to be performed in a purpose built enclosure or semi-enclosure to reduce noise levels to acceptable levels. Even within this enclosure the testing of engines will need to occur within 0700 and 1800 hours so that unacceptable levels of noise are not generated.

7.5 Dust

An assessment of the construction of Murrayfield using EPA guidelines has shown that there will be a negligible risk of dust generation inconveniencing neighbours. This risk will be further reduced by the conducting of major earthworks during the wetter months of the year (Section 4.5) as soils will be damp and less prone to generate dust. In addition, winds tend to be lighter this time of year and less able to transport dust.

Despite the above, the proponent is willing to commit to controlling dust so that it does not inconvenience neighbours. Water carts will be used to dampen soils should they start to generate significant amounts of dust, and exposed areas will be seeded with a suitable grass after the completion of work should wind generated dust become a problem.

8. CONCLUSION

This CER has identified a number of potential environmental impacts that could result from the construction and operation of the Murrayfield Airpark and Resort Complex. Analysis of these impacts have found them to be relatively minor.

Noise generated by fixed wing aircraft using the aerodrome, and phosphorus export from the site as a result of fertiliser application and sewage disposal are considered to be the most significant potential impacts. It has been shown that phosphorus application to the site will actually drop by 65% and that with the selective use of runways there will be no increase in nuisance noise level to existing residents. It is therefore concluded that these impacts are acceptable.

The impact on native vegetation will be balanced by a planting program throughout the development site. Impacts relating to groundwater extraction, construction and water quality are not anticipated. Even so the proponent is prepared to conduct monitoring programs designed to detect any unforeseen impacts should they occur. The results of these monitoring programs will be used to alter operations that result in any unacceptable environmental impacts.

Based on the above and the commitments made in this CER it is concluded that the proposed Murrayfield Airpark and Resort Complex will not unacceptably impact on the natural environment or on neighbouring residents.

9. COMMITMENTS

Commitments represent the proponents solutions to potential environmental problems posed by the development. Essentially they are promises by the proponent regarding the way in which certain aspects of the proposal will be carried out.

The Royal Aero Club of Western Australia and Hawkview Pty Ltd commit to carrying out the following commitments.

1. The proponents will ensure that all commitments and environmental conditions will be heeded and wherever necessary enforced by the lessees, management agencies and subcontractors involved in the construction and operation of the proposal.

2. The proponents will prepare a nutrient and irrigation management program prior to commencement of construction of the golf course and resort which will include the following:

   - fertiliser management types of fertiliser used, frequency of application (based on soil and tissue testing),
   - soil amendment details under fertilised and effluent irrigated area,
   - irrigation management (relating to the rational use of water for irrigation),
   - drainage management,
   - monitoring and as a consequence of findings, changes in management activities.

   The above will be implemented during the operation of the airpark and resort to the satisfaction of the EPA and the Waterways Commission.

3. Install and operate a sewage treatment plant that will remove phosphorus from sewage to a concentration of 2mg/L. The resulting effluent will be used for irrigation and solid waste will be disposed of off-site to the satisfaction of the EPA and Health Department.

4. Design and carry out a monitoring program to monitor groundwater levels, water levels in selected wetlands, and water quality parameter during the resorts operation to the satisfaction of the EPA and WAWA.

5. The proponents will, during construction and operation of the resort, maintain the existing functions of all wetlands that are to be retained on site. This will be achieved by preventing physical interference with or destruction of the wetlands, by nutrient management, and by not permitting any surface drainage

or effluents that originate from the aerodrome complex or resort discharging into any wetlands. This will be done to the satisfaction of the EPA.

6. Maintain wherever possible, the remnant vegetation on the site and embark on a planting program in which indigenous trees and shrubs together with other plants will be planted throughout the development area. This will be done to the satisfaction of the EPA.

7. Operate a policy of priority use of runways to reduce the level of noise experienced by residents to the satisfaction of the Shire of Murray.

8. Perform any engine tests between the hours of 0700 an 1800 within a purpose built enclosure designed to reduce the noise generated to acceptable levels with regard to nearby residents to the satisfaction of the Shire of Murray.

9. Ensure that construction activities that have the potential to create unacceptable levels of noise at nearby residences will only be carried out between 0700 and 1800 hours Monday through Saturday. This will be done to the satisfaction of the Shire of Murray.

10. Control dust during and after the construction phase should it be determined that dust levels are high enough to cause inconvenience to neighbouring residents. Dust control will principally be controlled by the use of water carts and will be done to the satisfaction of the Shire of Murray.

11. Store aviation fuel in above ground tanks which are fully bunded with a capacity in excess of the quantity of fuel stores, to the satisfaction of the Department of Mines.

12. Install structures such as interceptor pits and oil traps to prevent the spread of fuel that could be spilt from refuelling areas. This will be done to the satisfaction of the EPA.

REFERENCES

Department of Conservation and Environment, 1980. "The Peel-Harvey Estuarine System Study (1976-1980)." Hydrology and Meteorology Bulletin No. 89, DCE Perth.

del Marco A., 1990. "Turf Management in Perth." Water Authority of Western Australia.

Environmental Protection Authority, 1990. "An Environmental Protection Policy for Phosphorus Management in the Coastal Catchment of the Peel-Harvey Estuarine System." Prepared for the Environmental Protection Authority by the Western Australian Department of Agriculture.

Environmental Protection Authority 1990. "A Guide to Wetland Management in Perth." Bulletin 374

Kinhill Engineers Pty Ltd, 1988. "Peel Inlet and Harvey Estuary Management Strategy - Environmental Review and Management Programme - Stage 2 Summary."

McArthur & Bettenay, 1960. "Development and Distribution of the Soils of the Swan Coastal Plain." CSIRO Australian Soils Publication No.16.

Wells MR, 1989. "Land Capability Study of the Shires of Mandurah and Murray Land Resources Series No. 2." Prepared for the Western Australian Department of Agriculture.

Wells MR, and King PD, 1989. "Land Capability Assessment Methodology for Rural-Residential Development and Associated Agricultural Land Uses. Land Resources Series No. 1." Prepared for the Western Australian Department of Agriculture.

APPENDICES

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APPENDIX 1

GUIDELINES FOR CONSULTATIVE ENVIRONMENTAL REVIEW

GUIDELINES FOR CONSULTATIVE ENVIRONMENTAL REVIEW

These guidelines are prepared for Consultative Environmental Review (CER) for the proposed Murrayfield Park and Resort Complex at Lots 11 and 12 Nambeelup Road, Nambeelup, Shire of Murray.

These guidelines are issued as a checklist of matters which the Environmental Protection Authority (EPA) considers should be addressed in the CER. They are not exhaustive and other relevant issues may arise during the preparation of the document, these should also be included in the CER.

The form of the document is a matter for the proponent and the consultant, however, a sample of subject headings is attached.

A copy of these guidelines should appear in the CER.

1. Summary

It is desirable to provide a brief summary of:

- salient features of the proposal,
- alternatives considered,
- description of receiving environment and analysis of potential impacts and their significance,
- environmental monitoring, management and safeguards and commitments thereto, and
- conclusions.

2. Introduction

The CER should include a brief explanation of the following:

- identification of the proponent and responsible authorities,
- background and objectives of the proposal,
- brief details of, and timing of the proposal,
- relevant statutory requirements and approvals, and
- scope, purpose and structure of the CER.

3. Need for the Development

The CER should briefly examine the justification for the project and the costs and benefits (in the broad sense) at local and regional levels.

4. Evaluation of Alternatives

The CER should include details of:

- overall concept,
- location and layout,
- proposed land uses, land tenures and a clear distinction between boundaries of private and public land (as it applies),
- regional and local planning context,
- infrastructure including any air service support facilities (e.g. communication and meteorological facilities),
- access,
- auxiliary services (e.g. power, water and sewerage),
- construction schedule and methods of construction including source of materials and disposal of wastes, particularly wastewater treatment and disposal, and solid waste disposal in relation to sewerage facilities,
- control and staging of project,
- operation during and after construction, including management of the air strips, resort complex and golf course, and
- projected life of the project.

6. Existing Environment

The CER should provide an overall description of the environment and an appraisal of physical, ecological and social systems likely to be affected by the proposal. The CER should then concentrate on the significant aspects of the environment likely to be impacted by the development. Only the processes, habitats, resources, potential resources, communities and individuals which could be influenced should be defined.

The following matters should be addressed:

Physical:

- geology and geomorphology,
- soils including Phosphorus Retention Indices,

- hydrology and hydrogeology,
- drainage,
- wetlands, and
- export of nutrients from the proposed development and the impact on the Peel-Harvey Estuary system.

Biological:

- flora,
- fauna, and
- mosquitoes and disease.

Human:

- land use, including past land uses, land tenure and zoning,
- road systems and traffic,
- landscape,
- public access,
- any historical, archaeological and ethnographic sites, and
- existing adjacent land use, with particular attention being paid to the nearby abattoir and kennel zone.

This sub-section should provide a description of the affected community and any neighbouring individuals highlighting their characteristics where relevant.

The CER should, where appropriate, take cognisance of any other similar developments proposed for the general area.

7. Public Participation and Consultation

A description should be provided of the public participation and consultation activities to be undertaken by the proponent in preparing the CER. This section should describe the activities undertaken, the timetable for activities, the groups or individuals involved and the objectives of the activities. A summary of concerns raised should be documented. This section should be cross referenced with Section 9 which should clearly indicate how each of these concerns has been addressed.

8. Environmental Impacts

This is the most important part of the CER and the result should show the overall effect on all relevant aspects of the ecosystem and social surroundings of the location during and after construction.

The overall and incremental impact of the development on the local community and neighbours should be examined and described.

The objective is to take an overview of the elements of the system involved and the external factors with which they interact. This should include an assessment of the resilience of the systems identified in Section 6, to natural and people induced

pressures. Impacts should be quantified where possible. Criteria for making assessments of their significance should be outlined.

The following potential environmental impacts should be included:

- Noise - relevant to project construction and intended hours and areas of aircraft operations,
- Dust - pre and post construction management,
- water - availability and impact on groundwater protection area,
- drainage (relate to Peel-Harvey Estuarine System)*,
- vegetation clearing required for the project (relate to Peel-Harvey Estuarine System)*,
- water quality within any proposed golf course lake or drainage lake,
- services, that is, power, water and sewerage, with particular attention being paid to the latter in terms of effluent nutrient impact on the estuarine and groundwater systems,
- contingency planning and safety (including storage of aviation fuel),
- access (road and pedestrian),
- emissions (air, water, waste disposal),
- landscape,
- effect on the local community and facilities,
- land stability (with particular reference to areas disturbed during construction),
- construction and operational workforce, and
- impact on development (odour, noise) from adjacent kennel and abattoir uses.

The final synthesis should include an assessment of the significance and timing of the various potential impacts identified.

* Note: There is currently a moratorium on any further clearing and drainage in the Peel-Harvey coastal catchment. The CER should take cognisance of this and clearly detail how the proposed development will meet the objective of the moratorium.

9. Environmental Management

An environmental management programme should be described on the basis of, and cross-referenced to, the synthesis of potential environmental and social impacts. In particular, a Nutrient and Irrigation Management Programme should be prepared for the golf course.

The purpose of the overall management programme is to demonstrate the manner in which potential environmental and social impacts can be ameliorated.

Authorities responsible for management should be clearly identified as should management administration, costs and funding.

Elements of monitoring and the environmental management programme should include the impacts identified in Section 7.

Emphasis should be placed on the manner in which monitoring results will lead, where appropriate, to amendments to the management program.

Environmental safeguards should be described.

Procedures for reporting the results of monitoring and management to appropriate authorities should be given.

It is important that specific commitments are given to all components and procedures of the management program.

10. Conclusion

An assessment of the environmental acceptability of the project in terms of its overall environmental impact and in the context of the proposed management programme should be given.

11. Summary of Commitments by Proponent

Where an environmental problem has the potential to occur, the proponent should cover this potential problem with a commitment to rectify it. Where appropriate, the commitment should include:

a) who will do the work,
b) what the work is,
c) when the work will be carried out, and
d) to whose satisfaction the work will be carried out.

12. References

All references used in the CER should be listed.

13. Appendices

- Glossary - definitions of technical terms, abbreviations should be included.
- CER Guidelines - a copy of these guidelines should be included in the document.
- Ancillary or lengthy information related to discussion in the text of the CER.

APPENDIX 2

HYDROGEOLOGICAL REPORT

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HYDROGEOLOGICAL ASSESSMENT
MURRAYFIELD AIRPARK AND RESORT COMPLEX
NAMBEELUP, SHIRE OF MURRAY

SEPTEMBER 1991

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ALAN TINGAY & ASSOCIATES

HYDROGEOLOGICAL ASSESSMENT
MURRAYFIELD AIRPARK AND RESORT COMPLEX
NAMBEELUP, SHIRE OF MURRAY

SEPTEMBER 1991

1. INTRODUCTION

The Royal Aero Club and Resort Solutions propose to construct an airpark and resort complex at Lots 11 and 12, Nambeelup, in the Shire of Murray.

Rockwater was requested to carry out the following tasks, as part of the CER for the project:

(i) collate and assess existing records to determine the hydrogeology of the site,

(ii) investigate the relationship between surface water and groundwater

(iii) describe all known bores and wells within 1 km of the site

(iv) determine total N and total P loads in groundwater

(v) assess the effect on nearby bores of pumping groundwater for irrigation

(vi) prepare a groundwater monitoring programme to be implemented after commissioning the resort

This report presents the results of the hydrogeological assessment.

The property is gently undulating, and is formed by low fixed dunes (Bassendean Dunes) with some flat interdunal areas and swamps in depressions.

2. EXISTING BORES AND WELLS

Details of existing bores and wells were obtained:

(i) from records held by the Geological Survey of Western Australia, and

(ii) by a census of bores and wells within 1 km of the site, carried out by Rockwater.

The details are presented in Tables 1 and 2, and bore positions are shown in Figure 1.

2.1 BORE CENSUS

A census of bores around the Murrayfield site was conducted on 16 September 1991.

Eleven bores on nine properties in the Nambeelup Park development were surveyed. This development is situated between Gull Road and the Murrayfield site. Details of four other private bores and one bore on common land were not obtained because owners could not be contacted or the bores were inaccessible.

Four bores on Leedale Farm (owner J. Moore) and Wandalup Farms (Manager R. Wilson) were also surveyed.

During the census, electrical conductivity and temperature measurements were made on water samples for calculation of salinity, and water samples were collected from six bores for analysis of total phosphorus and nitrogen. Also, the results of nitrogen analysis for one water sample were obtained from Wandalup Farms. These results are discussed in Section 3.2

3. SITE HYDROGEOLOGY

3.1 GEOLOGICAL STRUCTURE

The area is surfaced by mainly fine to coarse or medium to coarse, pale grey or brown sand of the Bassendean Sand. The sand is commonly ferruginised near the water-table ("coffee rock"), and there are probably some fine grained sediments in low-lying areas. The Bassendean Sand extends to about 12 m depth (8 m AHD) near the northern boundary of the property, and is possibly deeper in the south.

TABLE 1
BORES VISITED DURING CENSUS
16 SEPTEMBER 1991

Location	Owner	Total Depth (m)	Static Water Level (m btc)	Slotted Interval (m bgl)	Total N (mg/L)	Total P (mg/L)	Salinity (mg/L TSS)	Comments
Lot 54, Nambeelup Park	Mr Gibson (prev. J. Pearson)	18.0	2.50	6-18	<5	0.01	100	Used for irrigation. Water brown and odorous, 760 m^3/d.
Lot 55, Nambeelup Park	(Not home)	N/A	N/A	N/A	-	-	N/A	Used for irrigation and possibly domestic purposes.
Lot 59, Nambeelup Park	Mr B. Thompson	17	N/A	11-17	<5	0.01	180	Used for irrigation and washing-down. Water brown and odorous.
Lot 62, Nambeelup Park	C/- Mr E. Knight							
A. Next to house		12	0.15	9-12?	-	-	310	Used for irrigation and washing down
B. SW corner of property		14	Flooded	11-14?	-	-	330	Bore not equipped
C. NW corner of property		11	0.16	8-11?	-	-	460	Used for irrigation (water in all 3 bores brown and odorous)
Lot 63, Nambeelup Park	R & W Godden	(Not home)		N/A	-	-	N/A	Used for irrigation
Lot 66, Nambeelup Park	(Lot Vacant)	N/A	N/A	N/A	-	-	N/A	Bore in pit, not cased or equipped.
Lot 72, Nambeelup Park	Mr R. Fitzgerald	18	0.49	12-18	<5	<0.01	540	Used for irrigation and washing down (water discolours on pumping leaving iron-oxide precipitate).
Lot 80, Nambeelup Park	(Not home)	N/A	N/A	N/A	-	-	N/A	
Gull Road Tank	Common	N/A	N/A	N/A	<5	0.06	620	Bore pit lid locked, water sampled from adjacent concrete storage tank.
Leedale Farm	Mr J. Moore							
A. Bore in shed		25.8	1.09	0-25.8	<5	0.16	300	Bores pumped in tandem, used for domestic, stock and irrigation. Combined yield approx. 324 cu m/d. Water brown and odorous. (GSWA Nos. 409 and 14?)
B. Bore adjacent to shed		25.8	N/A	Spear				
Wandalup Farm Nambeelup Road	Wandalup Farm							
A. Adjacent to piggery		50	N/A	N/A	-	0.25*	420*	Bores pumped in tandem, used for domestic, stock and irrigation. Water has high iron content. (GSWA Nos. 107 and 108). NO_3-N = <0.05 mg/L; NH4-N = 4.2 mg/L; Total Organic N = 4.2 mg/L
B. Adjacent to piggery		50	N/A	N/A				

* = Water quality information supplied by Wandalup Farm, from results of testing dated 11/4/91.
N/A = Not available

TABLE 2
BORES NEAR MURRAYFIELD SITE NOT VISITED DURING SURVEY
(FROM GEOLOGICAL SURVEY RECORDS)

Bore/Well	Location	Owner	GSWA No.	Total Depth (m)	Static Water Level	Slotted Interval (mg/L TDS)	Salinity (mg/L TDS)	Comments
Well	Approx 1.2 km WNW of Murrayfield, approx 400 m west of Gull Rd	N/A	2*	2	0.9	NIL	644 (Cl^-)	pH = 6.0
?	Approx 2 km W of Murrayfield on Nth side of Lakes Rd	N/A	10	1.8	N/A	N/A	N/A	Clear water beneath heavy blue clay
?	Approx 700 m N of Lakes Rd, 550 m W of Gull Rd	N/A	11	1.8	1.2	N/A	787	pH = 7.5
Well	Approx 1.3 km W of Murrayfield on Sth side of Lakes Rd	J. Moore	12	2.8	0.1	NIL	820	Abandoned, dry in summer, brown water
Dam	Approx 1.2 km W of Murrayfield, approx 200 m sth of Lakes Rd	Kirkman?	13	N/A	N/A	NIL	N/A	Pumps at approx 540 cu m/d for 8 hrs in summer. Probably now owned by P. Moore.
Bore	Approx 900 m SW of Murrayfield near Leedale Farm House	Kirkman?	14	6	0.9	N/A	286	Probably now owned by J. Moore and pumped in tandem with GSWA 409
Monitoring Bore	Adjacent to NE corner of Murrayfield	WAWA	48*	18	2.7	0-18	140	54 cu m/d, pH 5.5
Bore	Approx 1.1 km Nth of Murrayfield on Wandalup Farm	Wandalup Farm	109*	24	N/A	N/A	N/A	Old stock bore, equipped but not used
Bore	Approx 950 m SE of Murrayfield	Pope Export Pty Ltd	110	75	6.7	64.3-72.3	530	Was used for abattoir, pH = 6.5, Fe = 12 mg/L, NO_3 < 0.25 mg/L, NH_4 = 0.23 mg/L. Drilled by Swick Drilling 1978. Leederville Fmn aquifer.
Well	Approx 250 m SW of Murrayfield, approx 100 m Sth of Lakes Rd	Lilyvale Dairy	167	3.5	1.3	NIL	245	Abandoned
?	Approx 1.9 km W of Murrayfield, approx 350 m Nth of Lakes Rd	Fowler	175	7	1.0	N/A	85	Used for domestic purposes, supply ~65 cu m/d. Drilled in 1978. SWL in summer = 2.7 m
Bore	Approx 120 m Nth of Lakes Rd, adjacent to Airstrip. Approx 350 m west of Nambeelup Rd	Hawkview Holdings Ltd	554	~12	N/A	Spear	N/A	Old market garden bore, not equipped, 50 mm PVC pipe down to spear. Not potable. Details provided by Mr C. Ballantyne, September 1991.

* These GSWA numbers are from GSWA sheet reference 2033-II-C (All other bores are from GSWA sheet reference 2032-I-D).

The Leederville Formation of Cretaceous age lies unconformably beneath the Bassendean Sand. West of the property, the Rockingham Sand (of Tertiary age) lies within a channel cut into the Leederville Formation.

The Leederville Formation consists of interbedded sandstone, siltstone and shale, with beds typically less than 10 m thick. These sediments are pyritic, and the sandstone ranges from uncemented to well cemented.

3.2 GROUNDWATER, BASSENDEAN SAND

The Bassendean Sand contains groundwater that is recharged directly by the infiltration of rainfall. Recharge rates are expected to be high; about 20 to 30 percent of average rainfall. The water moves through the sand towards low-lying areas, discharging to swamps such as those that occur in the north-eastern and south-western corners of the property. The open water in these swamps in winter is a surface expression of the water table.

Hydraulic heads in the Bassendean Sand are estimated to be about 12 to 15 m AHD, about 5 m above heads in the Leederville Formation. There is the potential, therefore, for groundwater to seep downwards from the Bassendean Sand into the Leederville Formation, particularly where sandstone at the top of the Leederville Formation is in direct contact with the Bassendean Sand. The drillers log for the Pope Export bore indicates such a relationship occurs between the two formations south-east of the project site.

3.2.1 Water Quality

Water in the Bassendean Sand is generally fresh, with salinity ranging from about 100 mg/L to 800 mg/L TDS. It is commonly acidic (pH 4 - 6), and the water appears to contain high concentrations of iron oxide.

Water from five of the private bores visited during the bore census (Table 1) was sampled and analysed by Australian Assay Laboratories for total nitrogen and total phosphorus. The four bores sampled in Nambeelup Park all draw water from the Bassendean Sand; the Leedale Farm bores may be open to both the Bassendean Sand and top of the Leederville Formation.

Total nitrogen concentrations were low, and in all bores less than the lower limit of detection (5 mg/L). Total phosphorus concentrations were also low, ranging from <0.01 to 0.16 mg/L. The highest value was for the Leedale Farm bores.

3.3 GROUNDWATER, LEEDERVILLE FORMATION

Groundwater in the Leederville Formation is probably recharged from the overlying Bassendean Sand in the immediate area and further east, as discussed in Section 2.2. At depth, groundwater in the formation is confined by shale and siltstone beds. It is expected to be fresh, with salinity of 400 to 800 mg/L TDS, to at least to

100 m depth, but there is some brackish or saline water near the top of the formation about two kilometres west of the site, probably due to the proximity of the Rockingham Sand, which contains saline water.

3.3.1 Water Quality

The Pope Export bore is reported to yield water with a nitrate concentration of less than 0.25 mg/L, and ammonium ion 0.23 mg/L.

Details of a recent water analysis (dated 11 April 1991) provided by Wandalup Farms for their bores, which are believed to intersect the top of the Leederville Formation, include the following concentrations:

Total Dissolved Solids = 420 mg/L
NO_3-N = <0.05 mg/L
NH_4-N = 4.2 mg/L
Total Organic N = 4.2 mg/L
Total Phosphorus = 0.25 mg/L

These results indicate there are low concentrations of nitrogen and phosphorus in the Leederville Formation, although the concentrations are probably higher than in the Bassendean Sand.

4. SOURCES OF IRRIGATION WATER

The most prospective source of water for irrigation is the Leederville Formation. It is likely that a bore in this formation constructed to about 100 m depth would yield between 1,500 and 3,000 cu m/day. The actual yield will depend on the degree of cementing of sandstone beds, and the bore construction.

The shallow Bassendean Sands could also yield water for irrigation from bores or soaks, with estimated yields of up to 800 cu m/day. The old market gardens bore, situated south of the airstrip and east of the hanger was constructed to pump water from the Bassendean Sand. It is reported to have supported about 60 sprinklers, but it is unlikely that all these sprinklers were in operation at one time.

4.1 POTENTIAL EFFECTS OF EXTRACTION

4.1.1 Bassendean Sand

The Bassendean Sand forms an unconfined aquifer that discharges to swamps, under natural conditions. There is the potential, therefore, for groundwater extraction from the Bassendean Sand to reduce groundwater flow to, and water levels in, these swamps.

The Theis equation is used to estimate the drawdowns that could result from pumping a bore in the Bassendean Sand. This assumes homogeneous aquifer of infinite extent. The drawdowns given below also assume the following aquifer parameters:

aquifer thickness: 10 m
hydraulic conductivity: 20 m/day
specific yield: 0.15
pumping rate: 500 cu m/day
period of pumping: 180 days

Estimated Drawdowns Around Bassendean Sand Bore

Distance (m)	Drawdown (m)
5	2.0
100	0.8
500	0.2
1,000	0.04
2,000	0.02

From these figures, pumping a single bore near the centre of the property would have little effect on the swamps in the north-east and south-west corners of the property.

4.1.2 Leederville Formation

Pumping from the Leederville Formation is expected to have negligible effect on the shallow (Bassendean Sand) aquifer, provided the top of the screened section is at least 20 metres below the base of the Bassendean Sand.

The closest existing Leederville Formation bores are believed to be Pope Export bore, situated about 1 km south-east of the project site, and the Wandalup Farm bores, situated about 400 m north of the site. The Pope Export bore is not being used at present.

If an irrigation bore is constructed near the centre of the project site, it would be about 2 km from the Pope Export bore and 1 km from the Wandalup Farm bores. The potential additional drawdown that could be induced at these bores is calculated using the Theis Equation, and the following assumed parameters:

Pumping Rate = 3,000 cu m/day
Pumping Period = 180 days
Hydraulic Conductivity = 10 m/day
Aquifer Thickness = 25 m
Storage coefficient = 0.001

This calculation indicates the drawdown induced at the Pope Export bore could be 3.1 m, and at the Wandalup Farm bores 4.4 m, but it is expected that the actual drawdowns would be lower as the Murrayfield bore would not be pumped continuously, and the effective storativity could be higher than 0.001 because of leakage from adjoining aquifers.

5. PROPOSED MONITORING PROGRAMME

The following groundwater monitoring programme is recommended for implementation once the resort has been commissioned:

1. Record weekly pumpage using a water meter, and instantaneous pumping rate measured from the rate of revolution of the water meter.

2. Measure water levels in the production bore(s) and selected swamps weekly, and record whether the bore is operating or not when the measurement is taken. It is recommended that shallow piezometers be installed alongside two of the swamps so that swamp water levels can be monitored throughout the year.

3. Measure electrical conductivity, temperature and pH of water from the bore(s) weekly.

4. Every three months, collect a sample of water from the bore(s) and from the swamps and analyse for concentrations of major ions, total nitrogen and total phosphorus.

The data collected would be used with monitoring data collected by the Water Authority from their nearby Lake Thompson and Artesian Monitoring bores (LT650, AM65, AM66) to prepare an annual monitoring report, as will be required by conditions of the Well Licence for the bore.

6. CONCLUSIONS

Moderate supplies of groundwater for irrigation could be drawn from the surficial Bassendean Sand aquifer, although there is the potential for extraction to affect swamps such as those in the north-eastern and south-western corners of the property. Additionally, shallow private bores west of the property might be affected.

Large supplies of groundwater would be available from the underlying Leederville Formation. There would be little or no effect from pumping on shallow bores or swamps, provided the top of the bore screens are at least 20 m below the top of the Leederville Formation. Interference drawdowns of about 4 m could be induced in the Wandalup Farm bores, but actual drawdowns are likely to be smaller because of inter-aquifer leakage and intermittent pumping.

Water from both aquifers is low in nitrogen and phosphorus.

DATED: 24 SEPTEMBER 1991

ROCKWATER PTY LTD

P H WHARTON
PRINCIPAL HYDROGEOLOGIST

389 000 E

390 000 E

391 000 E

392 000 E

109

N
(GRID NORTH)

6 403 000 N

107, 108

Wandalup Farm Shallow Monitoring Bore

Wandalup Farm (Quarantine Area)

2

48

GULL ROAD

Lot 72

SUNSHINE PL.

Lot 80

Lot 63

D'RAYNE GL

Possible Bore position

6 402 000 N

Nambeelup Park Development

Lot 66

MURRAYFIELD AIRPARK SITE

NAMBEELUP ROAD

11

GULL RD

TANK

Lot 59

C

Lot 62

A

B

WINDFIRE GR

Lot 54

Airstrip

Lot 55

554

LAKES ROAD

6401 000N

12 813

167

Old Abattoir Site

LEEDALE

409

14

PATERSON ROAD

110
(Pope Export Bore)

6400000N

168

0 500 1000m

Scale 1:15000

LEGEND

107 • Bore surveyed (September 1991).

167 ○ Bore not surveyed (with GSWA No.)

ø Bore, position doubtful.

Road.

Track /private road.

Swamp area.

FIGURE 1

Client : A. TINGAY & ASSOCIATES

Project : MURRAYFIELD AIRPARK & RESORT

LOCALITY PLAN SHOWING BORE POSITIONS

Date : September 1991 Dwg. No. 168-0/91/1-1

ROCKWATER PTY LTD

APPENDIX 3

ABORIGINAL SITE SURVEY

REPORT ON AN ARCHAEOLOGICAL SURVEY FOR ABORIGINAL SITES AT THE PROPOSED GOLFCOURSE AND AIRFIELD AT MANDURAH AIRPORT

Prepared for Alan Tingay and Associates

By Jacqueline Harris

On behalf of Quartermaine Consultants

September 1991

ARCHAEOLOGY - TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Background to Survey

An Aboriginal site survey of a proposed development for a golfcourse and airfield at Mandurah Airport was commissioned by Alan Tingay and Associates. Jacqueline Harris conducted the research and archaeological survey in September, 1991.

The purpose of the investigation was to facilitate planning of the development programme. The conduct of the archaeological work was as follows:

1. The assembly of data from previous work in the region,including information from W.A. Museum Aboriginal site files, previous survey reports, maps and environmental data.

2. A comprehensive survey of the project area including the location and recording of archaeological sites within the designated survey area.

1.2 Location

The proposed development area is located some 4.25 kms east of the junction of Serpentine River and Goegrup Lake. The area is delineated by Lakes Rd on the southern border, Nambeelup Road on the eastern border and fence lines on the remaining borders. The square plot comprises some 20 hectares of swamp, grazing land, and a small airport.

1.3 Environment

The south-west region of Western Australia is characterised as a dry Mediterranean climate consisting of hot dry summers and mild wet winters. Rainfall occurs between May and October, followed by summer droughts from January to April when little or no precipitation eventuates (Beard 1990).

The survey area lies within the Swan Coastal Plain of the Perth Basin, a deep trough filled with Phanerozoic sedimentary rocks. The surface of the Swan Coastal Plain consists of Quaternary alluvial and aeolian sediments of varying age. The system of Swan Coastal Plain wherein the survey area is located is known as the Bassendean Dunes. It consists of low vegetated hills of quartz sand with numerous interdunal swamps and lakes (Biggs, et al, 1980, McArthur & Bettenay, 1960).

Generally Banksia low woodland features in the Bassendean Sands but south of Serpentine River the system becomes more swampy with Banksia low woodland occupying only the highest dunes. Freshwater swamps are bordered by paperbark,

Melaleuca rhaphiophylla, with sedges and bullrushes extending into the water while seasonally flooded swamps are covered by M. preissianna with Banksia littoralis and Eucalyptus rudis (Beard 1990).

Ephemeral swamps and land subject to flooding from the recent winter rains comprised more than 50% of the survey area. The remainder consisted of cleared grazing land with small isolated pockets of medium to scattered woodland. Sections of the southern portion had been graded and cleared as required for activities associated with airports.

1.4 Previous Archaeological Research

The earliest evidence for prehistoric occupation of the South-West of Australia is dated at 38,000 years ago, for a stratified site at Upper Swan, located 25 km northeast of Perth (Pearce and Barbetti, 1981). A number of Holocene sequences have yielded data on possible cultural/environmental changes during, and after, the recent transgression of the sea, for the metropolitan region (see Clarke and Dortch, 1977; Hallam, 1974; and Pearce, 1978). This work postulates increased populations on the Coastal Plain, rising to a peak just before European contact.

As part of a regional survey of the Metropolitan area, Hallam (1986:5) concludes that the majority of sites lie around the lakes and swamps of the Swan Coastal Plain, and that site numbers double in the last few hundred years. Four phases of occupation are suggested for the Coastal Plain. These are:

1. a. Early - low number of sites centred towards the coast. Artefacts include steep scrapers on flakes and scrapers made from an Eocene fossiliferous chert. This phase was up to 5000 years ago.

   b. Middle - from 5000 - 500 years ago. Showed a contraction of occupation to sites near permanent water. Artefacts were made on quartz and green chert and included backed blades, adzes, scrapers and flakes.

   c. Late - from 500 years ago. Concentration of sites on the Coastal Plain. Fabricators (bipolar cores) were introduced and a large percentage of assemblages were made up of quartz flakes, chips and debitage (Hallam, 1973, 1974 and 1986).

   d. A recent historic phase, which was characterised by the use of European introduced material, such as glass and pottery, for the manufacture of artefacts, encompasses the last 150 years.

   Prehistoric stone tool industries in the South-West have been classified into earlier and later phases (Dortch, 1977). The early phase industries have only been documented from a few well-dated sites. They include small thick flake

scrapers, bipolar cores, notched-denticulated pieces, flakes from discoidal cores, and single and multi-platform cores. These artefacts have been manufactured from a range of lithic materials, including a distinctive Eocene fossiliferous chert. It appears that access to this chert was lost after the last marine transgression (Dortch, 1977; Glover, 1975). However, some of this chert may have been subject to curation over a period of time and loss of access to the source does not necessarily indicate a complete halt in its use in archaeological assemblages.

Later phase stone industries, generally found in archaeological contexts dating from 4,000 years ago, include the addition of geometric microliths, backed blades, and a variety of adze flakes, which are part of the Australian "small tool tradition" (Dortch, 1977; Mulvaney, 1975).

Anderson (1984) has proposed a land-use model for prehistoric exploitation of the Swan Coastal Plain, and its hinterland, based on regional research into the relative proportions of variously sized surface artefact scatters and their associated artefact densities. This model suggests that, due to the variation in

2. Resources available in the three different environmental zones investigated, there was more intensive use of the coastal plain than either the adjacent forest or open woodland plateau.

No archaeological sites have been previously recorded on, or in close proximity to, the project area. However, 5 archaeological sites and 1 ethnographic site have been recorded within 5 kms of Mandurah Airport as detailed in Table 1 (O'Connor, et al. 1985, Quartermaine, 1987).

The archaeological sites are mostly medium quartz artefact scatters containing 30-60 artefacts. Only one site, S1296 contains a few artefacts made from fossiliferous chert. The assemblages consist of flakes, cores and chips as well as several implements such as steep and utilised scrapers, a microadze and a fabricator. All recorded sites are located either adjacent to watercourses or on the margins of swamps. The majority occur on devegetated sandy slopes undergoing erosion from natural processes and/or human disturbance.

TABLE 1 : Previously Recorded Sites near Survey Area

SI 50-2 1:250,000 Mapsheet

WA Museum Site No.	Grid Ref.	Site type	Site name
SO0185	385.402	Artefacts	Stake Hill Bridge

SO1296	393.402	Artefacts	Drain
SO2436	393.405	Artefacts	Lakes Road
SO1297	394.401	Artefacts	Tortoise Swamp
SO8616	395.398	Artefacts	Gas Pipeline 84
SO2226	386.400	Camp/hunting fish traps	Goegrup Lake 2

From the existing information, it is possible to make the following observations:

i. Small, low density surface artefact scatters are the most numerous recorded archaeological sites;

ii. Quartz is the dominant lithic material used for the manufacture of artefacts;

iii. Flakes and chips form the major class of artefact types in the recorded artefact assemblages; and

iv. River margins, swamp and lake margins, and areas of devegetated sand are the main site locations.

3.

2.0 METHODS

2.1 Obligations under the Act

The Western Australian Aboriginal Heritage Act, 1972-1980, makes provision ...

"...for the preservation on behalf of the community of places and objects customarily used by or traditional to the original inhabitants of Australia or their descendants, or associated therewith, and for other purpose incidental thereto."

The Act defines the obligations of the community relating to sites (see Appendices 1 & 2).

An archaeological survey is aimed at identifying the effects of proposed disturbance of the physical environment on historic and pre-historic Aboriginal sites.

The consultant is obliged to submit site documentation on appropriate forms for lodgement and submission to the Department of Aboriginal Sites, W.A. Museum, for any newly recorded Aboriginal sites.

2.2 Investigation Methodology

The survey design involved the following stages of operation.

i. Background research - this involved familiarisation with W.A. Museum site files, survey reports, plus maps and environmental information for the area to be surveyed. Previously recorded Aboriginal sites, registered with the W.A. Museum, are listed in Table 1.

ii. Survey strategy - this consisted of a systematic survey of the proposed development area.

The field survey was conducted using a 25,000 topographic map as well as a 1:50 aerial map of the survey area.

The project area was surveyed using east-west orientated transects at 50m intervals. In addition, swamp margins and devegetated sandy patches were intensively surveyed. Visibility varied markedly from 10%-40% on swampy margins, 20%-30% over grazing land, 30%-40% on woodland pockets, to 100% on devegetated sandy patches.

Given the fact that over 50% of the project area was inundated, it is considered that the dry land mass received 100% survey coverage. A large proportion of the project area has been previously cleared, particularly in the southern section where it also had been subject to grading.

2.3 Site Definitions

Aboriginal material culture is based, to a large extent, on non-durable materials, such as wood, bark, fibre and skins, that have a limited life in the archaeological record. Stone tools, conversely, remain as often the only evidence of prehistoric activity. Bone, either as a tool, as refuse, or as a burial, falls somewhere between these extremes. Lofgren (1975:7) describes spears, spear-throwers and clubs for men, and digging sticks, wooden carrying dishes and grindstones for women, as the basic implements of Aboriginal life.

Therefore, stone artefact sites reflect only one aspect of Aboriginal material culture which utilised a wide range of materials from the natural environment.

For the purpose of this investigation, an archaeological site is defined as "any place containing traces of past human activity" (Fagan, 1980:7). This is manifested in a number of different site components which may occur singularly or with one or more of the others to form an archaeological site. The most common of these are surface artefact scatters, quarries, art sites, stone arrangements, rockshelters with evidence of occupation, grinding patches, shell middens, burials and marked trees. An artefact scatter is recorded as a site if it contains three or more artefacts in association. Areas of solitary artefacts, called Isolated Finds, are recorded but not reported as Aboriginal sites.

The above definition of archaeological sites is a scientific definition. The assessment as to whether such sites are covered by the provisions of the W.A. Aboriginal Heritage Act, 1972-1980, Section 5, is made for the Trustees of the W.A. Museum by the Aboriginal Cultural Material Committee. Such assessment is undertaken as part of a Section 18 application for site disturbance. When sites are discussed in this report, it is in the context of the scientific definition and not Section 5 of the above Act.

As samples will not be collected in the field, it is important to standardise a recording format that will be of use for analysis and have relevance for other researchers. Categories under which site data will be recorded are as follows:

i. Site dimensions - extent and type:

ii. Artefact assemblage - number, type, lithic material, and dimensions of artefact;

iii. Environmental setting - vegetation, soil, drainage and proximity to water, surface visibility and disturbance.

iv. Stratigraphy - assessment of potential.

2.4 Significance Assessment

The significance of an archaeological site is determined by its ability to address regional and specific research questions and by its representativeness (Bowdler, 1981; 1984). For example, unique sites are more significant than commonly occurring sites, and sites with stratified deposits are more significant than unstratified sites. Significance is a mutable quality, changing as more sites are recorded, questions are answered or new directions in research arise.

Research questions that sites in the Yanchep area may address include:

a. specific and particular patterns in the nature of Aboriginal occupation of this zone;

b. technological, demographic and social changes, if any, which occurred in the region in the mid-Holocene; and

c. the antiquity and the nature of colonisation of the coastal zones of Australia.

3.0 RESULTS

No archaeological sites, as defined by Section 5 of the Aboriginal Heritage Act, 1972-80, were located in the field survey. Therefore the issue of significance does not arise.

However, two isolated finds were recorded on sandy embankments either side of the runway at the airport in the southern section of the project area.

Isolated Find 1 consisted of a quartz flake measuring 22mm long, 15mm wide and 10mm thick. The striking platform measured 14mm long and 10mm wide.

Isolated Find 2 consisted of a utilised fossiliferous chert flake measuring 32mm long, 27mm wide and 12mm thick with the striking platform measuring 10mm long and 4mm wide.

While the two artefacts were almost directly opposite each other on either side of the runway but 64 metres apart, it could be postulated that the artefacts were the remnants of an artefact scatter, having been inadvertantly disturbed in the recent past when the area was cleared and graded for an airport runway. However, given the absence of any other artefacts, the extent of disturbance from grading, clearing and ditching and the artefacts lack of provenance as a result of soil displacement from earth moving equipment it is considered that their position is most likely circumstantial.

Taking into account the list of sites recorded within 5kms of the area and their respective locations around water sources, it was considered that the project area exhibited a high potential for the likelihood of artefact scatters. However low visibility, as a result of lush ground cover from abundant winter rains particularly around swamps and in grazing areas, reduced the probability of locating sites. The lack of visibility factor, is minimised, if environmental factors such as over 50% of the survey area being subject to swamps and flooding, the ephemeral nature of the water sources, and the few small patches of higher ground in the area, are considered. Therefore the potential of the area for site location is markedly reduced.

4.0 CONCLUSIONS

4.1 Discussion

An Aboriginal site survey of a proposed development for a golfcourse and airfield at Mandurah Airport was commissioned by Alan Tingay and Associates. The area, comprising some 200 hectares of swampland, cleared grazing land, and a small airport, is situated north of Lakes Road and west of Nambeelup Road.

The archaeological survey strategy involved an investigation of previous research in the area, a systematic field survey of the project area consisting of a series of transects spaced 50 metres apart as well as predictive sampling of selected areas, and the recording of any archaeological material located.

No archaeological sites were located in the field survey. Therefore the issue of significance does not arise. Two isolated artefacts were located in the southern sector of the project area. The isolated finds are consistent with artefact assemblages that have been previously recorded in the region.

Whilst theoretically the project area offered high potential for the location of Aboriginal sites, the fact that over 50% of the land mass was inundated with water reduced its potential. Nevertheless the potential for isolated artefacts as a result of sporadic hunting and food gathering activities was considered high.

4.2 Recommendations

The recommendations which follow are based on field observations and investigations of previously recorded sites in area.

1. Given the lack of any archaeological sites within the boundaries of the proposed development area, it is therefore recommended that adequate archaeological investigations have been carried out and that in terms of the archaeological component the development be allowed to proceed.

2. It is recommended that developers take adequate measures to inform any project personnel of their obligation to report any archaeological material, should this be encountered during earthmoving, as outlined under Section 15 of the Aboriginal Heritage Act, 1972-80.

Acknowledgements

The information and assistance provided by Emma Quartermaine and Gary Quartermaine is gratefully acknowledged.

5.0 REFERENCES

Anderson, J. (1984) Between Plateau and Plain. Occasional Papers in Prehistory, No. 4. A.N.U., Canberra.

Beard, J.S. (1990) Plant Life of Western Australia. Kangaroo Press, N.S.W.

Biggs, E.R., Leech, R.E.J. and Wilde, S.A. (1980) Geology mineral Resources and Hydrogeology of the Darling System, Western Australia. Atlas of Natural Resources, Darling System, Western Australia. Dept of Conservation and Environment, Perth.

Bowdler, S. (1981) Unconsidered Trifles? Australian Archaeology 12: 123-133.

Bowdler, S. (1984) Archaeological significance as a mutable quantity. In S. Sullivan & S. Bowdler (eds) Site Survey and Significance Assessment in Australian Archaeology, pp 1-9. R.S.P.S., A.N.U., Canberra.

Clarke, J. and C.E.Dortch. (1977) "A 10,000 year BP radio carbon date for archaeological finds in a soil of the Spearwood Dune system, Mosman Park, W.A." Search, 8:36-38.

Dortch, C.E. (1977) "Early and late stone industrial phases in Western Australia" in Wright, R.V.S. (ed.) Stone Tools as Cultural Markers. A.I.A.S. Canberra: 104 - 132.

Fagan, B. (1980) People of the Earth. Little, Brown and Company, Boston.

Glover, J E. (1975) "The petrology and probable stratigraphic significance of Aboriginal Artefacts from part of south-west Australia". Journal of the Royal Society of Western Australia, 58:75-85.

Hallam, S.J. (1973) Ecology and demography in southwestern Australia. Journal of the Royal Society of Western Australia, 56:46-48.

Hallam, S.J. (1974) "Excavations at the Orchestra Shell Cave,

Wanneroo, Western Australia". Archaeology and Physical Anthropology in Oceania, 9: 66 - 84.

Hallam S.J. (1986) Prehistoric Aboriginal Populations on the Swan Coastal Plain, Western Australia. Final Report on the project: Australian Research Grants Scheme.

Lofgren, M. E. (1975) Patterns of Life. Western Australian Museum Information Series No. 6.

McArthur, W.M. and Bettanay, E. (1960) The development and distribution of the soils of the Swan Coastal Plain, Western Australia. Soil Publication No. 16. C.S.I.R.O. Australia.

Mulvaney, D.J. (1975) The Prehistory of Australia. Penguin, Melbourne.

O'Connor, R., Bodney, C. and Little, L. (1985) Preliminary Report on the Survey of Aboriginal Areas of Significance in the Perth Metropolitan and Murray River Regions. Report to Australian Heritage Commission.

Pearce, R.H. (1978) "A dated sequence from Walyunga. Western Australia." Journal of the Royal Society of Western Australia, 61: 1 - 10.

Pearce, R.H. & M. Barbetti. (1981) "A 38,000 year old archaeological site at Upper Swan, Western Australia". Archaeology in Oceania, 16: 173-178.

Quartermaine, G. (1987) Report of an Archaeological Survey of the Proposed Kwinana to Kemerton 330kV Powerline Route. Report to Dames and Moore.

APPENDIX 1

OBLIGATIONS RELATING TO SITES UNDER THE ABORIGINAL HERITAGE ACT, 1972-1980

Report of Findings

"15. Any person who has knowledge of the existance of anything in the nature of Aboriginal burial grounds, symbols or objects of sacred, ritual of ceremonial significance, cave or rock paintings or engravings, stone structures or arranged stones, carved trees, or of any other place or thing to which this Act applies or to which this Act might reasonably be suspected to apply shall report its existance to the Trustees, or to a police officer, unless he has reasonable cause to believe the existance of the thing or place in question to be already known to the Trustees."

Excavation of Aboriginal Sites

"16.

(1) Subject to Section 18, the right to excavate or to remove any thing from an Aboriginal site is reserved to the Trustees.

(2) The Trustees may authorise the entry upon and excavating of an Aboriginal site and the and the examination or removal of any thing on or under the site in such manner and subject to such conditions as they may direct."

Offences Relating to Aboriginal Sites

"17. A person who-

(a) Excavates, destroys, damages, conceals or in any way alters any Aboriginal site; or

(b) In any way alters, damages, removes, destroys, conceals, or who deals with in a manner not sanctioned by relevant custom, or assumes the possession, custody or control of, any object on or under an Aboriginal site, commits an offence unless he is acting with the authorisation of the Trustees under Section 16 or the consent of the Minister under Section 18."

Consent to Certain Uses

"18.

(1) For the purposes of this section, the expression "the owner of any land" includes a lessee from the Crown, and the holder of any mining tenement or mining privilege, or of any right or privilege under the Petroleum Act, 1967, in relation to the land.

(2) Where the owner of any land gives to the Trustees notice in writing that he requires to use the land for a purpose which, unless the Minister gives his consent in this Section, would be likely to result in a breach of Section 17 in respect of any Aboriginal site that might be on the land, the Trustees shall, as soon as they are reasonably able, form an opinion as to whether there is any Aboriginal site on the land, evaluate the importance and significance of any such site, and submit the notice to the Minister together with their recommendations in writing as to whether or not the Minister should consent to the use of the land for that purpose, and, where applicable, the extent to which and the conditions upon which his consent should be given.

(3) When the Trustees submit a notice to the Minister under subsection (2) of this section he shall consider their recommendation and having regard to the general interest of the community shall either -

(a) Consent to the use of the land the subject of the notice, or a specified part of the land, for the purpose required, subject to such conditions, if any, as he may specify;

or

(b) Wholly decline to consent to the use of the land the subject of the notice for the purpose required,

and shall forthwith inform the owner in writing of his decision.

(4) Where the owner of any land has given to the Trustees notice pursuant to the subsection (2) of this section and the Trustees have not submitted it with their recommendation to the Minister in accordance with that subsection the Minister may require the Trustees to do so within a specified time, or may require the Trustees to take such other action as the Minister considers necessary in order to expedite the matter, and the Trustees shall comply with any such requirement.

(5) Where the owner of any land is aggrieved by a decision of the Minister made under subsection (3) of this section he may, within the time and in the manner

prescribed by the rules of court, appeal from the decision of the Minister to the Supreme Court which may hear and determine an appeal.

(6) In determining an appeal under subsection (5) of this section the Judge hearing the appeal may confirm or vary the decision of the Minister against which the appeal has been made or quash the decision of the Minister, and may make such order as to the costs of the appeal as he sees fit.

(7) Where the owner of the any land gives notice to the Trustees under subsection (2) of this section, the Trustees may if they are satisfied that it is practicable to do so, direct the removal of any object to which this Act applies from the land to a place of safe custody.

(8) Where consent has been given under this section to a person to use any land for a particular purpose nothing done by or on behalf of that person pursuant to, and in accordance with any conditions attached to, the consent constitute an offence against the Act."

APPENDIX 2

Notes on the Recognition of Aboriginal Sites

There are various types of Aboriginal Sites, and these notes have been prepared as a guide to the recognition of those types likely to be located in the survey area.

An Aboriginal Site is defined in the Aboriginal Heritage Act, 1972-1980, in Section 5 as:

(a) Any place of importance and significance where persons of Aboriginal descent have, or appear to have, left any object, natural or artificial, used for, or made for or adapted for use for, any purpose connected with the traditional cultural life of the Aboriginal people, past or present;

(b) Any sacred, ritual or ceremonial site, which is of importance and special significance to persons of Aboriginal descent;

(c) Any place which, in the opinion of the Trustees is or was associated with the Aboriginal people and which is of historical, anthropological, archaeological or ethnographical interest and should be preserved because of its importance and significance to the cultural heritage of the state;

(d) Any place where objects to this Act applies are traditionally stored, or to which, under the provisions of this Act, such objects have been taken or removed."

Habitation Sites

These are commonly found throughout Western Australia and usually contain evidence of tool-making, seed grinding and other food processing, cooking, painting, engraving or numerous other activities. The archaeological evidence for some of these activities is discussed in details under the appropriate heading below.

Habitation sites are usually found near an existing or former water source such as a gnamma hole, rock pool, spring or soak. They are generally in the open, but they sometimes occur in shallow rock shelters or caves. It is particularly important that none of these sites be disturbed as the stratified deposits which may be found at such sites can yield valuable information about the inhabitants when excavated by archaeologists.

Seed Grinding

Polished or smoothed areas are sometimes noticed on/near horizontal rock surfaces. The smooth areas are usually 25cm wide and 40 or 50cm long. They are the result of seed grinding by the Aboriginal women and indicate aspects of past economy.

Habitation Structures

Aboriginal people sheltered in simple ephemeral structures, generally made of branches and sometimes of grass. These sites are rarely preserved for more than one occupation period. Occasionally rocks were pushed aside or used to stabilise other building materials. When these rocks patterns are located they provide evidence for former habitation sites.

Middens

When a localised source of shellfish and other foods has been exploited from a favoured camping place, the accumulated ashes, hearth stones, shells, bones and other refuse can form mounds at times several metres high and many metres in diameter. Occasionally these refuse mounds or middens contain stone, shell or bone tools. These are most common near the coast, but examples on inland lake and river banks are not unknown.

Stone Artefact Factory Sites

Pieces of rock from which artefacts could be made were often carried to camp sites or other places for final production. Such sites are usually easily recognisable because the manufacturing process produces quantities of flakes and waste material which are clearly out of context when compared with the surrounding rocks. All rocks found on

the sandy coastal plain , for example, must have been transported by human agencies. These sites are widely distributed throughout the State.

Quarries

When outcrops of rock suitable for the manufacture of stone tools were quarried by the Aborigines, evidence of the flaking and chipping of the source material can usually be seen in situ and nearby. Ochre and other mineral pigments used in painting rock surfaces, artefacts and in body decoration are mined from naturally occurring seams, bands and other deposits. This activity can sometimes be recognised by the presence of wooden digging sticks or the marks made by these implements.

Marked Trees

Occasionally trees are located that have designs in the bark which have been incised by Aborigines. Toeholds, to assist the climber, were sometimes cut into the bark and sapwood of trees in the hollow limbs of which possums and other arboreal animals sheltered. Some tree trunks bear scars where section of bark or wood have been removed and which would have been used to make dishes, shield, spearthrowers and other wooden artefacts. In some parts of the state wooden platforms were built in trees to accommodate a corpse during complex rituals following death.

Burials

In the north of the state it was-formerly the custom to place the bones of the dead on a ledge in a cave after certain rituals were completed. The bones were wrapped in sheets of bark and the skull placed beside this. In other parts of Western Australia the dead were buried, the burial position varying according to the customs of the particular area and time. Natural erosion, or mechanical earthmoving equipment occasionally exposes these burial sites.

Stone Structures

If one or more stone are found partly buried or wedged into a position which is not likely to be the result of natural forces, then it is probable that the place is an Aboriginal site and that possibly there are other important sites nearby. There are several different types of stone arrangements ranging simple cairns or piles of stones to more elaborate designs. Low weirs which detain fish when tides fall are found in coastal ares. Some rivers contain similar structures that trap fish against the current. It seems likely that low stone slab structures in the south west jarrah forests were built to provide suitable environments in which to trap some small animals. Low walls or pits were sometimes made to provide a hide or shelter for a hunter.

Elongated rock fragments are occasionally erected as a sign or warning that a special area is being approached. Heaps or alignments of stones may be naturalistic or symbolic representations of animals, people or mythological figures.

Paintings

These usually occur in rock shelters, caves or other sheltered situations which offer a certain degree of protection from the weather. The best known examples in Western Australia occur in the Kimberley region but paintings are also found through most of the states. One of several coloured ochres as well as other coloured pigments may have been used at a site. Stencilling was a common painting technique used throughout the state. The negative image of an object was created by spraying pigment over the object which was held against the wall.

Engravings

This term described designs which have been carved, pecked or pounded into a rock surface. They form the predominant art form of the Pilbara region but are known to occur in the Kimberleys in the north to about Toodyay in the south. Most engravings occur in the open, but some are situated in rock shelters.

Caches

It was the custom to hide ceremonial objects in niches and other secluded places. The removal of objects from these places, or photography of the places or objects or any other interference with these places is not permitted.

Ceremonial Grounds

At some sites the ground has been modified in some way by the removal of surface pebbles, or the modeling of the soil, or the digging of pits and trenches. In other places there is not noticeable alteration of the ground surface and Aborigines familiar with the site must be consulted concerning its location.

Mythological Sites

Most sites already described have a place in Aboriginal mythology. In addition there are many Aboriginal sites with no man-made features which enable them to be recognised. They are often natural features in the landscape linked to the Aboriginal Account of the formation of the world during the creative "Dreaming" period in the distant past. Many such sites are located at focal points in the creative journeys of mythological spirit beings of the Dreaming. Such sites can only be identified by the Aboriginal people who are familiar with the associated traditions.

APPENDICES

APPENDIX 4

NOISE IMPACT STUDY

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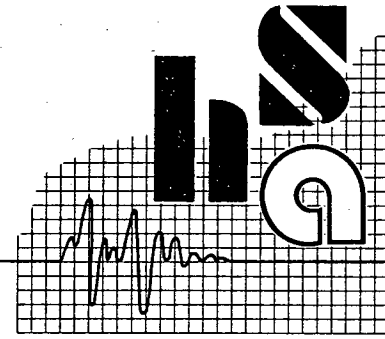


ALLAN HERRING M.I.E. AUST. M.A.A.S.
LYNTON STORER M.A.I.E.A., M.A.A.S.

MURRAY FIELD AIRPARK

ENVIRONMENTAL NOISE STUDY

OCTOBER 1991

(Our ref. 1031-91085)

1.0 INTRODUCTION

A study has been undertaken to assess the acoustic impact of the proposed Murray Field Air Park on the surrounding area.

This report sets out the method of assessment, findings of noise impact due to construction, aircraft operations, park operations and also considers impact to the resort due to surrounding industry and where considered necessary recommends control and management methods to reduce impact.

2.0 CONCLUSION

2.1 Aircraft Noise

Development of a new runway and increased flight frequencies would not increase noise emission in terms of ANEF contours or maximum levels to the existing residential properties providing a policy of priority use of the new runway is adopted.

It is recommended that some areas of rural land be restricted from residential dwellings as they fall within the ANEF 25 contour. Also that it be a statutory requirement that any dwellings within the ANEF 20 - 25 contour have appropriate noise attenuation incorporated into the structure as defined in Australian Standard 2021-1985.

2.2 Helicopter Noise

Noise from helicopter operations does not impact on any existing residents. Excessive noise levels will be experienced on vacant rural land to the west of Nambeelup Road for approximately 100m and similarly dwellings should be restricted from, or have conditional construction within the 75 dB(A) contour.

2.3 General Operational Noise

General operations of the resort/aircraft facilities will not impact on the existing residential or other areas, although some procedural management may need to be adopted to restrict some operations from night time or weekends.

Noise due to aircraft engine testing is likely to marginally affect existing residents and noise attenuating enclosures is recommended to be incorporated at the design stage. Also some operational constraints may be required for night time or weekend use.

Noise due to piggery and dog kennel areas is unlikely to impact on the resort development.

Construction noise will impact on the existing residential area, but should be tolerable within defined limits. However, some restrictions of operational times and/or locations may be required.

3.0 METHOD

Recordings of the existing sound levels were made in order to assess the ambient conditions due to existing aircraft, traffic and industry.

Calculations of noise propagation from various sources were made and assessed against background measurements and guidelines set out by the Environmental Protection Act 1986 Regulations.

Fixed wing aircraft are assessed based on Civil Aviation Authority (CAA) produced Australian Noise Exposure Forecast (ANEF) contours and guidelines.

Helicopters are assessed based on the EPA guidelines

Airport operations and construction noise are assessed based on EPA Regulations and emissions determined by modelling using the Environmental Noise Model computer programme.

4.0 ACCEPTABLE CRITERIA

Acceptable Criteria for Residential Areas

The nearest residential location to the proposed development is along Gull Road, off Lakes Road, This is specially zoned for dog kennel usage.

Under the current guidelines set down by the Environmental Protection Authority, acceptable levels for such an area are defined as, (hereafter refer to as "assigned" levels):

50 dB(A)	0700 - 1900 hrs	Monday - Saturday inclusive
40 dB(A)	2200 - 0700 hrs	On any day
45 dB(A)	At any other time	

Intrusive noise levels may be adjusted to reflect annoying characteristics such as tonal components (hereafter referred to as adjusted level).

Measurements of existing background sound levels gave the following statistical data for day time with aircraft activity. The measurement location was equivalent to the nearest residence and directly under the flight path.

Percentile Unit	L10	L50	L90	Leq	Lmax
Sound Level dB(A)	49	36	31	50	71

No audible sound was evident due to kennel or piggery activity. Nearby abattoirs were not operational.

The assigned levels would be applicable to the operational activities of the complex such as aircraft maintenance activities, golf course maintenance activities, resort mechanical plant, etc.

Aircraft noise can be assessed by the use of the Australian Noise Exposure Forecast (ANEF) system and Australian Standard 2021-1985 Acoustics - Aircraft Noise Intrusion - Building Siting and Construction. The ANEF is used as an overall guide for residential siting and AS-2021 as a more specific assessment of annoyance values.

With the ANEF contours the following criteria is suggested:

ANEF	<20	Acceptable
ANEF	20 - 25	Conditional
ANEF	>25	Unacceptable

Conditional meaning the likely need of sound insulation included in building construction.

AS-2021, Table F1 gives the following maximum noise level criteria for acceptability for residential use:

<79	Acceptable
75 - 85	Conditional
>85	Unacceptable

Other criteria sites an LeqAh of less than or equal to 55 dB(A) as being acceptable.

Helicopter noise has been assessed using the EPA's Helicopter & Helicopter Landing Sites Policy which uses a noise level contour envelope giving acceptable and unacceptable criteria, similar to an ANEF envelope but based on maximum sound levels. The acceptable maximum levels are:

Up to 10 flights per 12 hour day	80 dB(A) max.
10 - 15 flights per 12 hour day	78 dB(A) max.
Greater than 15 flights per 12 hour day	76 dB(A) max.

Further where the ambient LAeq is less than 55 dB(A) then ambient LAeq should not be increased by more than 5 dB(A) due to helicopter activity or beyond 57 dB(A).

Construction noise is a more general assessment without firm guidelines other than the E.P.A. 1986 Regulations. It is widely accepted however, that construction noise up to 10 dB(A) above ambient levels will be tolerated providing:

1. It is understood that it is for a defined and relatively short period.

2. That no impulsive or tonal characteristics of the noise are sustained.

3. That the noise occurs within reasonable day light hours (0700 - 1700 hours) and to a lesser extent on Saturdays and not on Sundays.

Based on the assigned criteria noise levels of up to 60 dB(A) would be tolerable.

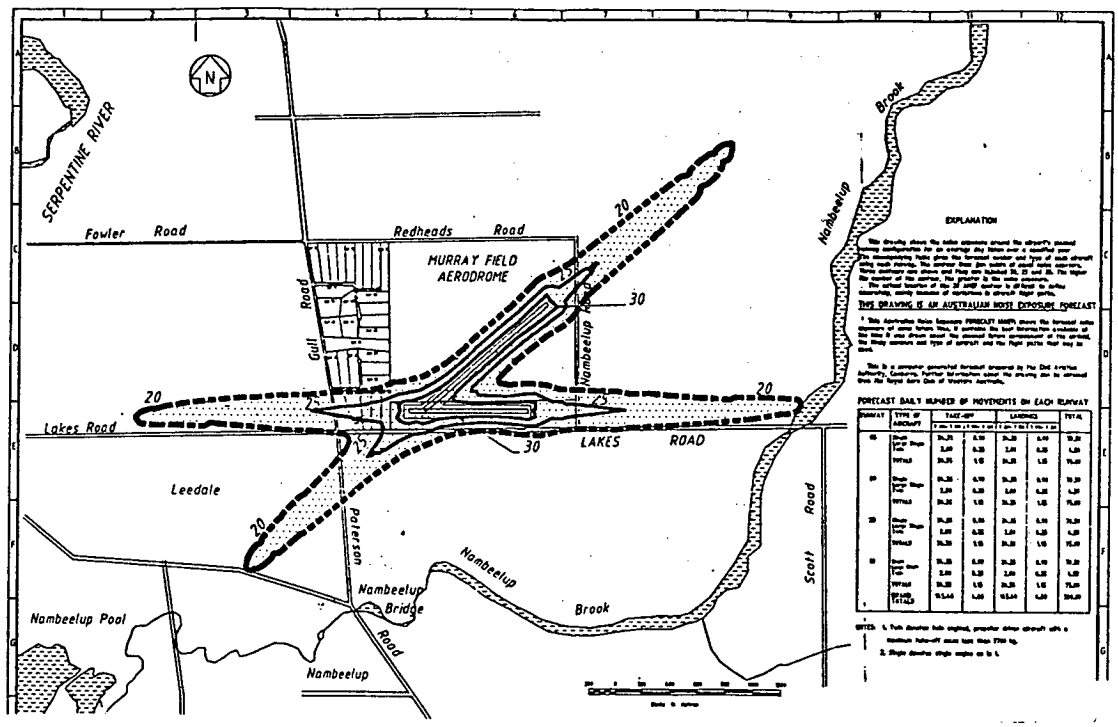
5.0 RESULTS & DISCUSSION

5.1 Fixed Wing Aircraft

The CAA - ANEF contour map is shown in Figure 1 and on Drawing 91085/1.

This map is plotted for total future aircraft usage with equal distribution of takeoffs and landings between all runways (03, 09, 23 & 27).

Figure 1



It can be seen from Figure 1 that some residential lots (and existing residences) fall within the 25 contour, specifically due west of runway 09 (27).

This is somewhat of an existing situation as, at present, runway 09 (27) is the only existing runway and hence used by all aircraft. If a policy of priority use of runway 03 (23) were to be adopted, then the ANEF levels, in terms of the Gull Road lots, would in fact be less than the present usage. A study of the yearly wind strength and direction distribution for this area shows that runway 03 (23) could be used for all but 12% of the time.

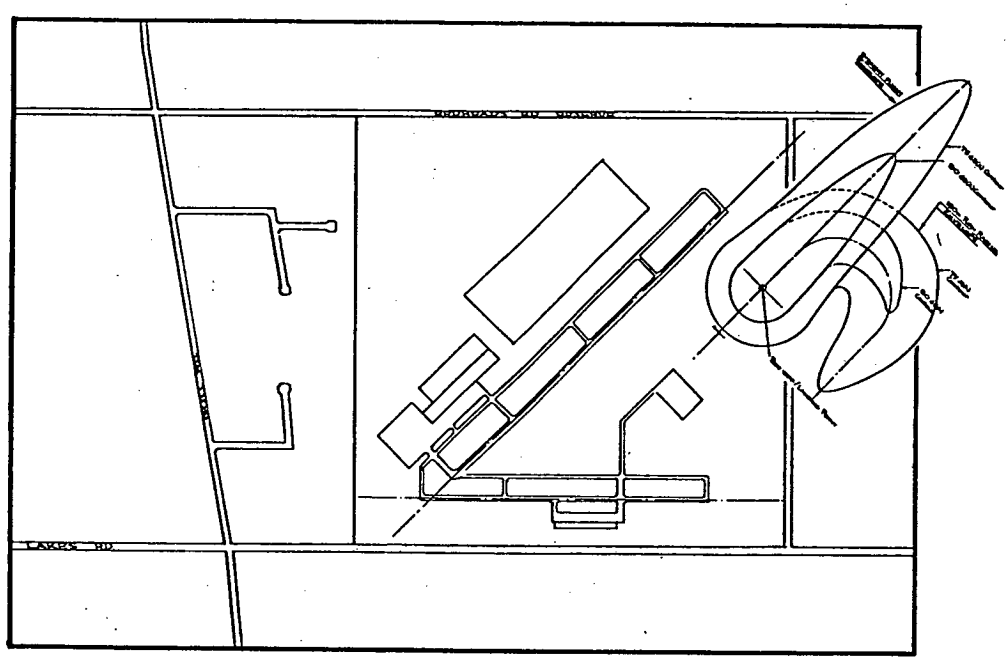
The area in question would still fall within the conditional 20 - 25 category, but as mentioned this would be equal to, if not less than the current situation and hence acceptable.

The measurements taken of existing sound levels, in particular aircraft noise, showed maximum levels of 71 dB(A), and LeqA of less than 50, and based on criteria of a maximum noise level of 75 dB(A) and LeqAh of 55 being acceptable, further supports the above conclusion. It is recommended that no further residential development be considered on existing rural land where ANEF contours of over 25 occur and that development in areas of contours between 20 - 25 be conditional upon extra sound insulation being incorporated in construction.

5.2 Helicopters

An overlay of the "acceptable" helicopter noise footprint is shown in Figure 2 and on Drawing 91085/4.

Figure 2



Clearly the 80 dB(A) footprint is confined within the air park boundary. The 75 dB(A) contour projects some 100 metres into adjacent rural land to the east. This envelope does not affect any existing residences and hence no noise will impact on existing residences, however, as for the ANEF contours, development of residences within the footprint should be restricted (75 dB(A) contour).

5.3 General Operations

Operations due to golf course maintenance, aircraft workshops and resort mechanical services plant are unlikely to unduly impact on residences based on the 50 dB(A) assigned day time level, providing the following precautions are taken in either operational procedures or design:

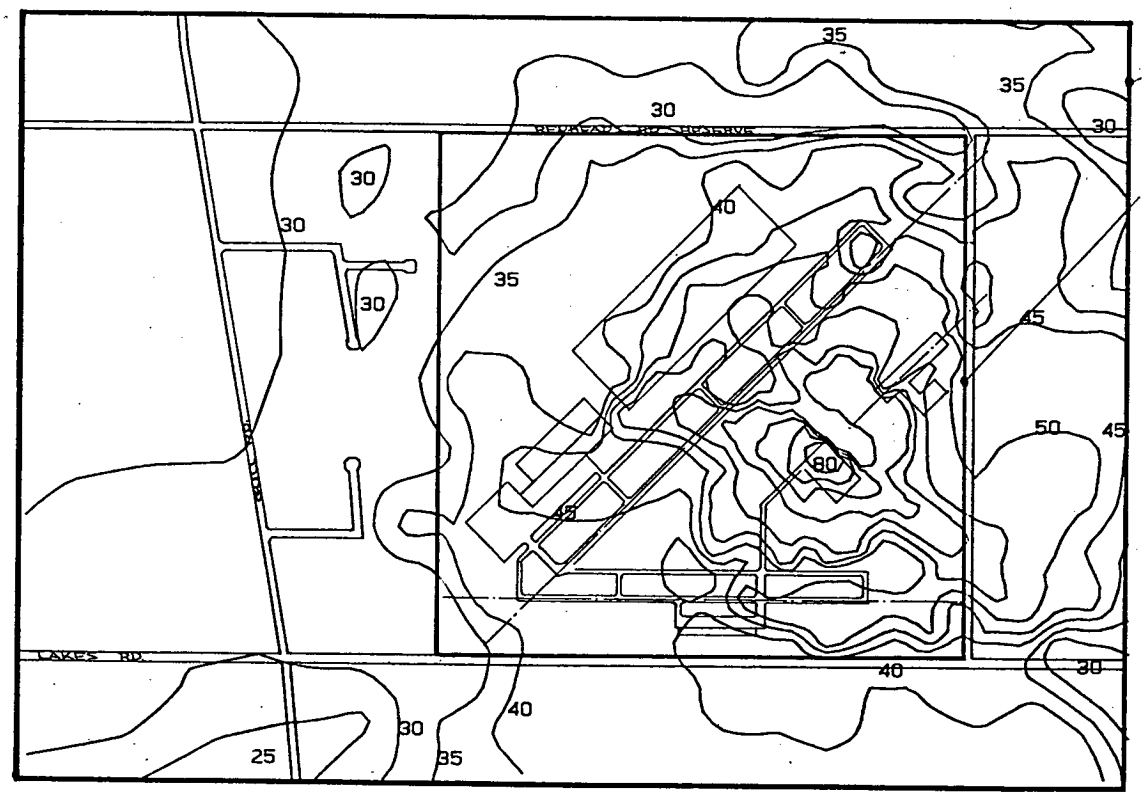
1. The use of golf course ground maintenance equipment, i.e. mowers, are restricted to Monday - Saturday operation, 0700 - 1900 hours.

2. Workshop facilities are completely housed within hanger areas or special purpose buildings.

3. Air conditioning/ventilation plant, emergency generator, etc. for the complex are specifically engineered to ensure compliance with 40 dB(A) at the nearest residence. This is practically achievable.

Noise propagation due to run up testing of aircraft engines has been computer modelled with resultant noise level contours shown in Figure 3 and on Drawing 91085/2.

Figure 3



The predictions show levels of up to 35 dB(A) to the Gull Road residential area and up to 55 dB(A) to the adjacent eastern rural area. Noise from this operation is likely to be particularly annoying due to frequency modulation and tonal components and after adjustment for these characteristics wouldbe 45 and 65 dBA respectively. Although the area to the east is proposed to be restricted use for residential due to aircraft and helicopter noise, the testing would still impact on the western residential area if testing were conducted other than 0700 to 1900 Monday to Saturday.

The testing of engines should be carried out within a purpose built enclosure or semi-enclosure to reduce noise levels from this operation to 30 dB(A) when measured at the Gull Road residential area. Again, this is practically achievable with standard engineering practices. Even with the above controls it is likely some restrictions on testing will be necessary, such as no operation within the period 2200 - 0700 hours.

5.4 Kennel Zoning & Piggery

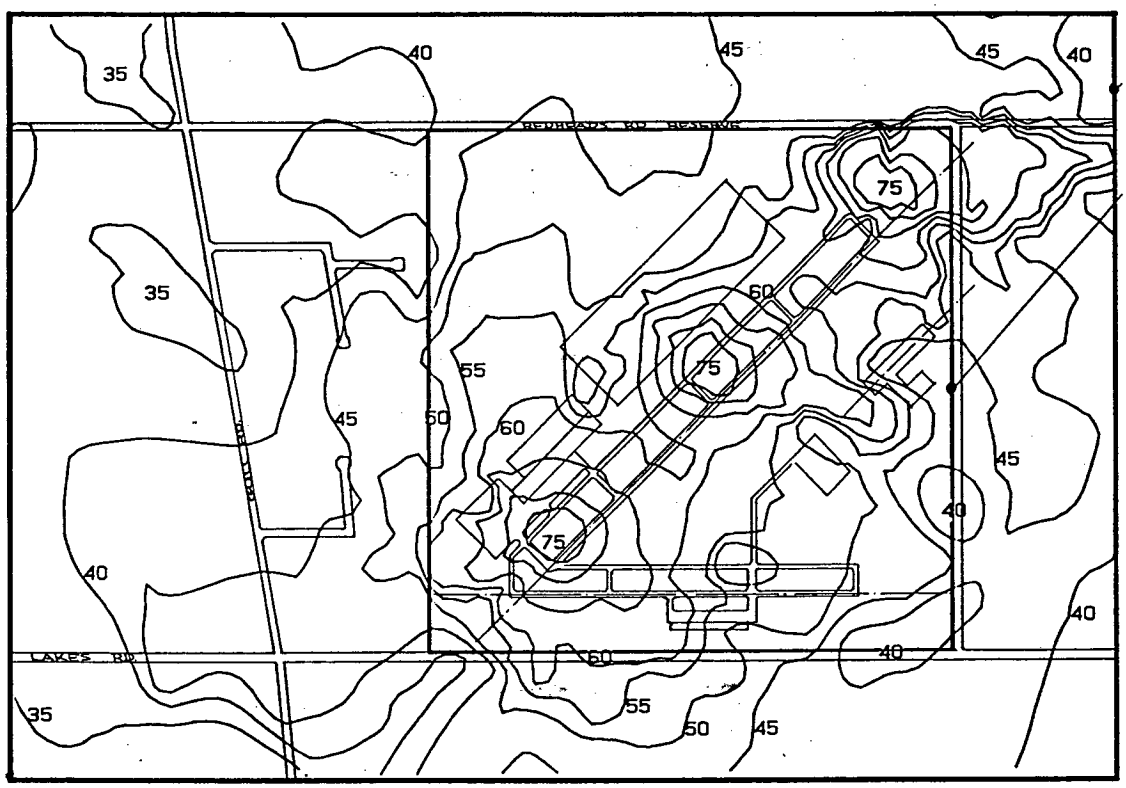
No discernible noise from operations of the piggery were evident during site measurements. The only influence was from traffic (very sparodic) travelling along Nambeelup Road to the piggery. This noise was not noticeable above normal traffic flows. There were also no noticeable noises in the way of dog barking detected from the kennel zone, however, this area is not as yet fully developed or occupied. From previous studies, it has been shown development, without any specific noise control measures, is acceptable at 500 metres or more from an operational kennel zone. The resort complex is at about 500 metres from the nearest kennel zone boundary. Also some barrier effect due to golf course contours and trees/shrubs would provide extra attenuation of noise from barking dogs. It is therefore concluded that noise impact from dog barking on the proposed resort will be negligible.

5.5 Construction Noise

Construction is expected to occur over a 3 - 4 month period, the main noise sources being the operation of heavy earthmoving equipment and the trucking of runway materials to the site.

Computer modelling of earthmoving equipment operating on the site has been used to predict noise propagation to the nearest residences. Calculations are based on 2 scrapers, 3 trucks, 1 bulldozer, 1 grader and 1 front end loader operating simultaneously. The results are shown as noise level contours in Figure 4 and on Drawing 91085/3.

Figure 4



Predictions indicate noise levels of up to 50 dB(A) will occur due to construction activity at the south western end of the proposed runway. These levels would incur a penalty of +5dBA to reflect the annoyance characteristics of tonal components that would exist.

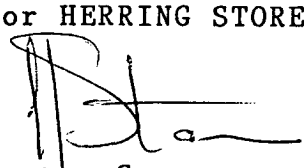
The predictions are based on equipment in good working order and sound suppression system in good order.

As previously stated, levels of up to 60 dB(A) are likely to be acceptable providing it is communicated that this is for a definative and relatively short period.

The levels of 50 dB(A) result from the operation of heavy earthmoving equipment at the south western end of the proposed runway and golf course operation. This will not occur for the full 4 month period, rather the maximum noise levels would occur for approximately 2 weeks.

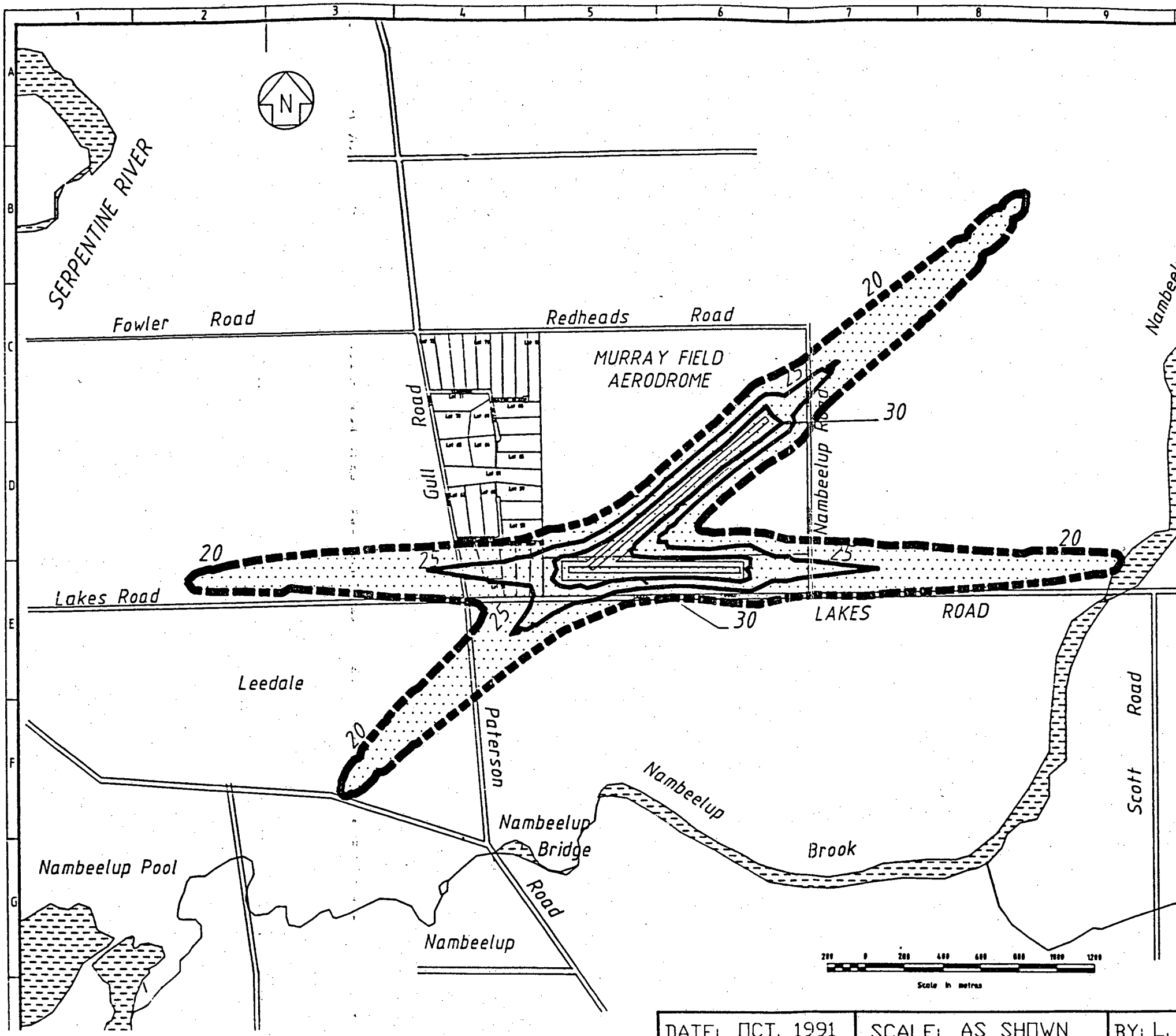
Construction operations should however be restricted to day light hours, Monday to Saturday inclusive, unless specific agreement is sought from nearby residents for work at other times.

for HERRING STORER ACOUSTICS



Lynton Storer

7 October 1991



EXPLANATION

This drawing shows the noise exposure around the airport's planned runway configuration for an average day taken over a specified year The accompanying table gives the forecast number and type of each aircraft using each runway. The contour lines join points of equal noise exposure. Three contours are shown and they are labelled 30, 25 and 20. The higher the number of the contour, the greater is the noise exposure.

The actual location of the 20 ANEF contour is difficult to define accurately, mainly because of variations in aircraft flight paths.

THIS DRAWING IS AN AUSTRALIAN NOISE EXPOSURE FORECAST

This Australian Noise Exposure FORECAST (ANEF) shows the forecast noise exposure at some future time. It contains the best information available at the time it was drawn about the planned future development of the airfield, the likely numbers and type of aircraft and the flight paths that may be used.

This is a computer generated forecast prepared by the Civil Aviation Authority, Canberra. Further information about the drawing can be obtained from the Royal Aero Club of Western Australia.

FORECAST DAILY NUMBER OF MOVEMENTS ON EACH RUNWAY

RUNWAY	TYPE OF AIRCRAFT	TAKE-OFF		LANDINGS		TOTAL
		7 AM- 7 PM	7 PM- 7 AM	7 AM- 7 PM	7 PM- 7 AM	
05	Single Large Single Twin	34.35 2.00	0.90 0.25	34.35 2.00	0.90 0.25	70.50 4.50
	TOTALS	36.35	1.15	36.35	1.15	75.00
09	Single Large Single Twin	34.35 2.00	0.90 0.25	34.35 2.00	0.90 0.25	70.50 4.50
	TOTALS	36.35	1.15	36.35	1.15	75.00
23	Single Large Single Twin	34.35 2.00	0.90 0.25	34.35 2.00	0.90 0.25	70.50 4.50
	TOTALS	36.35	1.15	36.35	1.15	75.00
18	Single Large Single Twin	34.35 2.00	0.90 0.25	34.35 2.00	0.90 0.25	70.50 4.50
	TOTALS	36.35	1.15	36.35	1.15	75.00
	GRAND TOTALS	145.40	4.60	145.40	4.60	300.00

NOTES: 1. Twin denotes twin engined, propeller driven aircraft with a maximum take-off mass less than 5700 kg.

2. Single denotes single engine as in 1.

DATE: OCT. 1991	SCALE: AS SHOWN	BY: L. STORER	DRG. NO. 91085/1

MURRAY FIELD AIRPARK
AUSTRALIAN NOISE EXPOSURE FORCAST

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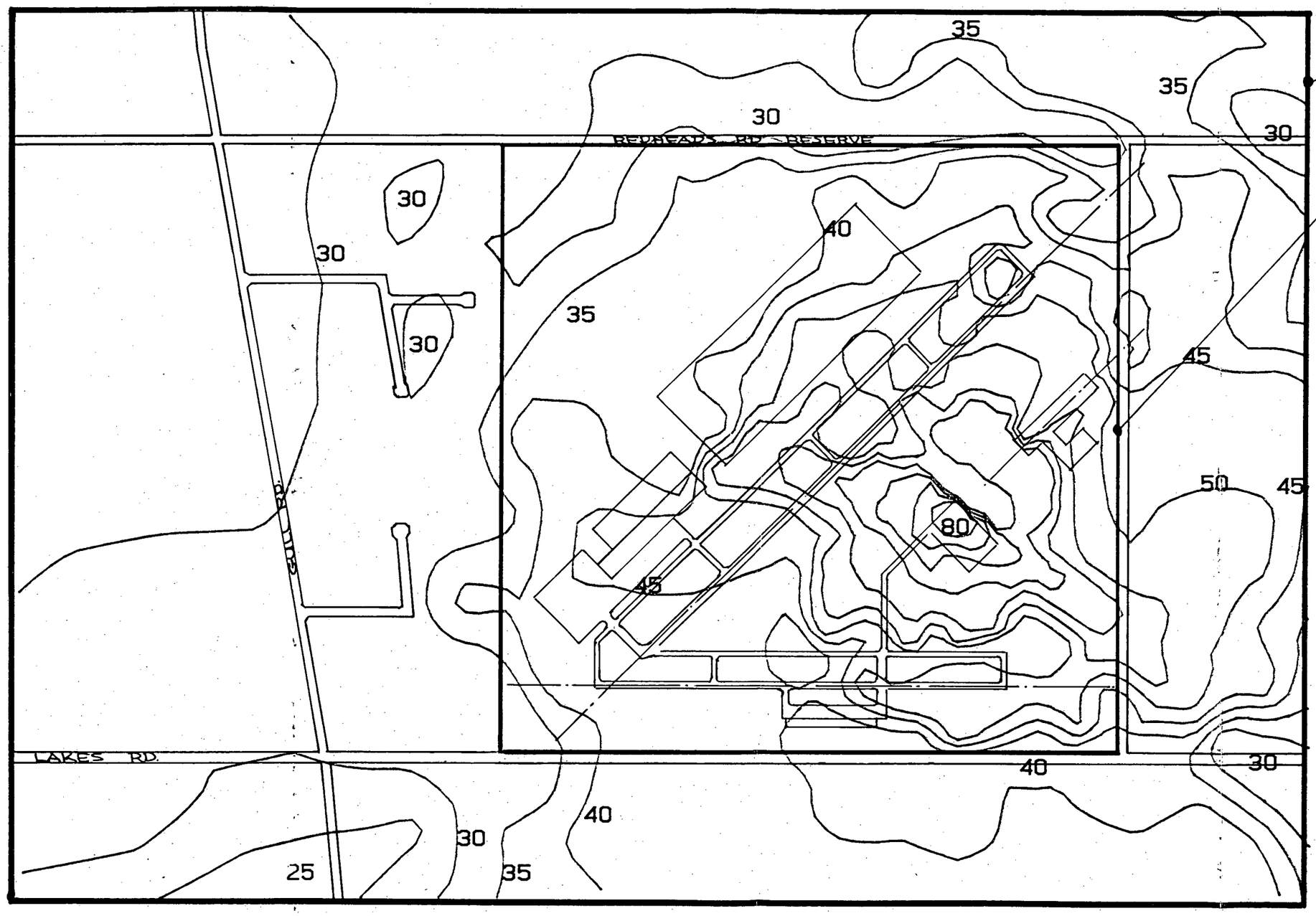

ALL LEVELS SHOWN ARE dBA
CONTOURS ARE AT 5dBA INERVALS

SCALE METRES

0 100 200 300 400 500

DATE: OCT. 1991	SCALE: AS SHOWN	BY: L. STORER	DRG. NO. 91085/2

MURRAY FIELD AIRPARK
ENGINE RUN-UP NOISE LEVELS

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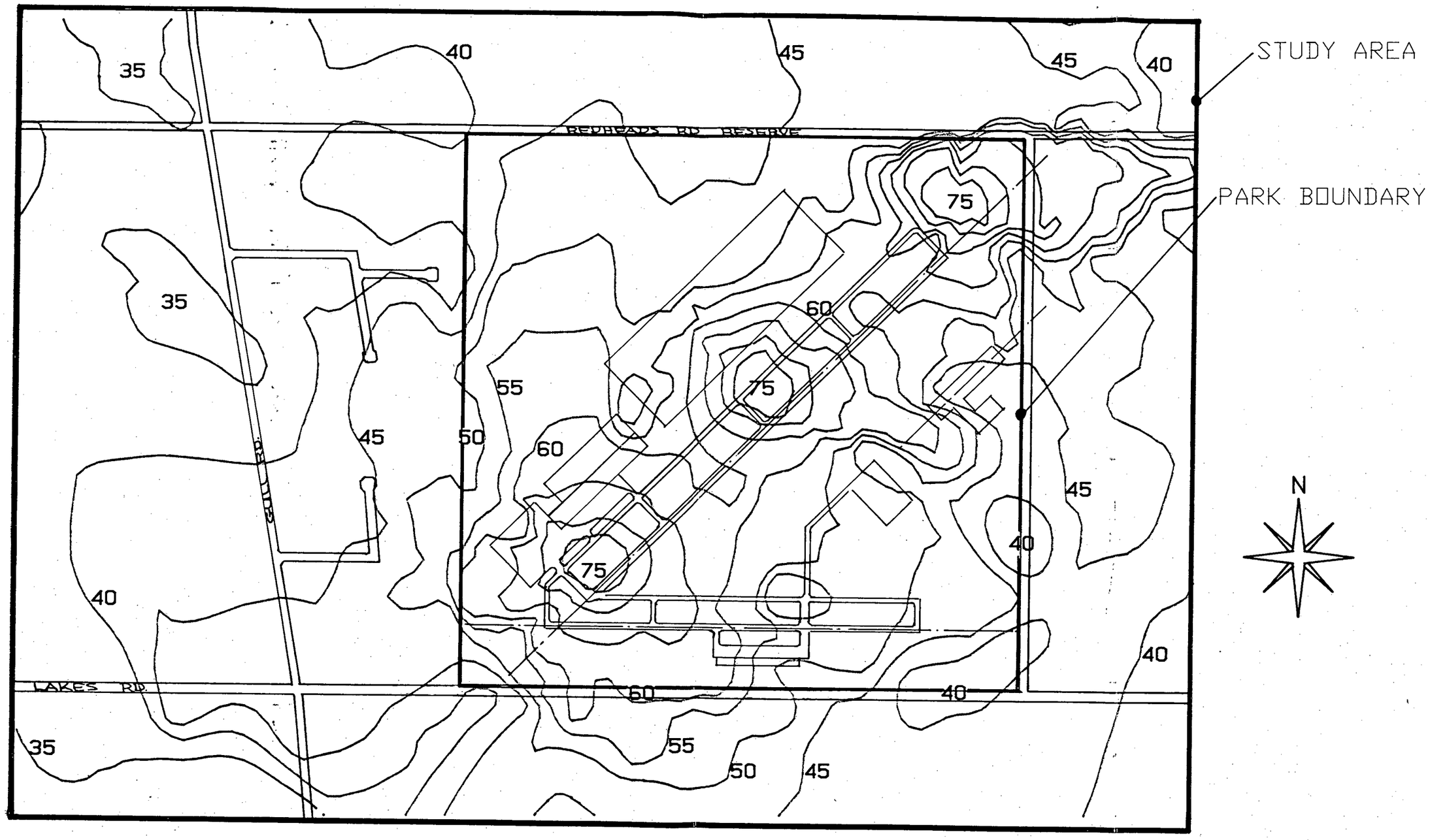

ALL LEVELS SHOWN ARE dBA
CONTOURS ARE AT 5dBA INERVALS

SCALE METRES

0 100 200 300 400 500

DATE: OCT. 1991	SCALE: AS SHOWN	BY: L. STORER	DRG. NO. 91085/3

MURRAY FIELD AIRPARK
CONSTRUCTION NOISE LEVELS

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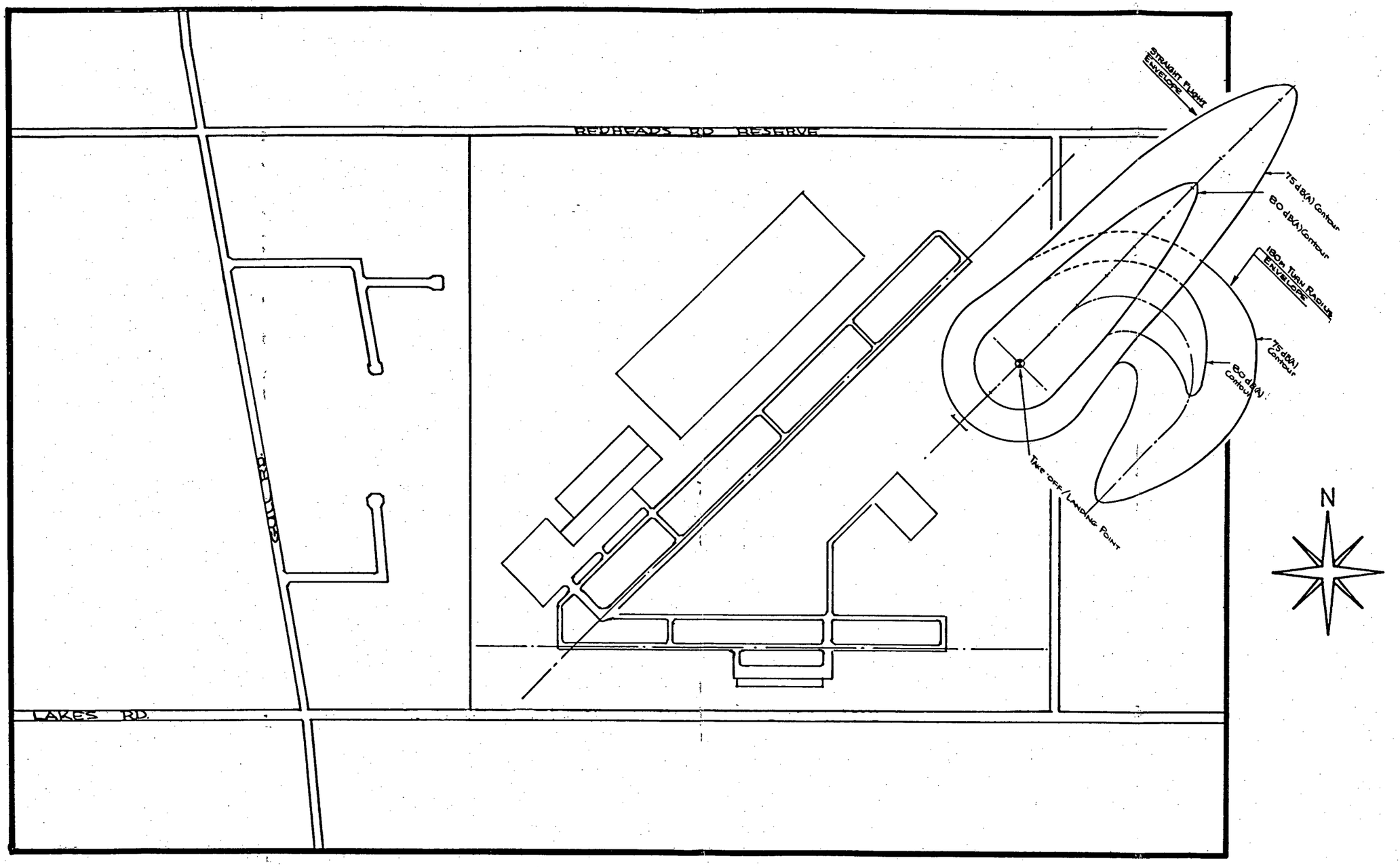

ALL LEVELS SHOWN ARE dBA
CONTOURS ARE AT 5dBA INERVALS

SCALE METRES

0 100 200 300 400 500

DATE: OCT. 1991	SCALE: AS SHOWN	BY: L. STORER	DRG. NO. 91085/4

MURRAY FIELD AIRPARK
HELICOPTER NOISE ENVELOPE

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APPENDIX 5

PUBLIC PARTICIPATION AND CONSULTATION REPORT

PUBLIC PARTICIPATION AND SOCIAL IMPACT STUDY

1. Method

A schedule of land owners within a 3km radius of the site was obtained from the Shire of Murray.

Where possible contact was made with the owners that had established or were establishing a residence, building or commercial operation on sites and appointments made for 2 members of the Executive Committee of the Royal Aero Club of Western Australia (RACWA) to visit the land owners site or meet at a mutually convenient location.

As telecommunications in the area are virtually non-existent sites were visited over a number of weekends to establish contact with the owners.

At the meetings following normal introductions and courtesies the agenda was:

i) An explanation of the purpose of the visit.

ii) Establishing contact with neighbours exchanging means and methods of communications and contact.

iii) Introduce and explain the role and purpose of the RACWA.

iv) Inform by way of presentation of the conceptual development plans of the Aviation Park.

v) Explanation of the operations of the airfield, the role of the RACWA as Airfield Manager and its operations, future plans, flight standards and general methods of operation.

vi) Appreciation of any concerns that had been raised and explanations as required.

vii) Advice as to methods of contact with the RACWA and persons to be contacted.

viii) Explanation of the requirement for the Social Impact Study and the Environmental Impact Study.

ix) Any other matters.

Following the initial meeting there were follow up meetings on site to further establish liaison and identify any areas of concern that may have arisen since the first meeting.

Where area of concern were identified liaison and communications on a personal basis has been maintained.

The study sampled 15 single/multiple owners that had established a residence, a commercial operation or with development in progress.

2. Issues

The issues raised were:

i) The effect of the rezoning of Nambeelup Park zoning for kennels.
Frequency: 1

ii) The operations of the airfield from a safety aspect.
Frequency: 3

iii) Access by local residents to resort facilities.
Frequency: 2

iv) Boundary fence re-alignment.
Frequency: 2

v) Plans for drainage of run-off flood water.
Frequency: 1

vi) Pilot responsibilities operating from the Airfield.
Frequency: 3

vii) Training student pilots.
Frequency: 3

viii) The advent of jet airliners.
Frequency: 1

ix) Compatibility of the piggery and proposed resort.
Frequency: 1

3. Responsibility for the Study

The Royal Aero Club of Western Australia was responsible for the study.

The President and General Manager of the RACWA were charged with undertaking the initial study and with the RACWA Murrayfield Senior Instructor/Manager to continue monitoring areas of concern with residents all of whom have been provided with both business and private contact facilities.

4. Report

a) Summary

There was a favourable response to the proposed development with one exception (2.1) in the first instance subject to explanations of the issues raised.

The operations of the aircraft from the airfield in general was not of concern in any instance, however, specific issues were raised (2.2, 2.6, 2.8).

The development of the resort was seen as positive progress for the development of the area as a whole with one exception (2.1) and this person requested access to the proposed park and the availability of the resort facilities to local residents.

The question with regard to the Airfield operations effect on livestock was dismissed by the residents and the Piggery Management as of no consequence in every instance.

All persons indicated that they were aware of the existing airfield operations and that there were no difficulties experienced.

b) **Specific Issues**

- The effect of the rezoning on Nambeelup Park zoning for kennels (Issue 2.1).

  This issue has been the reason for the only strong objection by any owner in the Nambeelup Park development and further communications and investigations indicated that the objection was raised because of dissatisfaction with a response from the Shire of Murray with regard to the tenure of the property concerned with a kennel licence. This has led to irrelevant and illogical issues being raised with regard to the proposed development and contact has been made with the Shire of Murray with regard to the position of the resident. A situation of which they were well aware.

  Ongoing contact has been made, however the issue is beyond the means of the RACWA to resolve.

- The operations of the airfield from a safety point of view (Issue 2.2).

  Enquiries were made with regard to safety rules and regulations for flying operations and when outlined this issue was of no concern.

  Air Navigation Orders, Civil Aviation Authority requirements and the aerodrome manual approved by the CAA are held on the aerodrome site by the aerodrome manager.

- Access by local residents to resort facilities (Issue 2.4).

  Access to the resort facilities would be by way of Resort Club Membership or RACWA Membership.

  The main facilities requested were the golf course, recreational facilities, bar and restaurant facilities.

- Boundary fence realignment (Issue 2.4).

  As a result of the Nambeelup Park Development it was discovered that the boundary fence on the western boundary of Lot 12 had been sited east of the actual boundary and the issue of cost of realignment was raised.

  All property owners adjoining this boundary were aware of the incorrect location of the fenceline.

  Advice was given to the effect that any realignment, if undertaken, would be at no cost to the owners of the adjoining properties.

- Plans for drainage of winter flood waters (Issue 2.5).

  The property owner on the north west boundary of Lot 12 expressed the view that the winter flood waters that flowed through the corner of their property from Lot 12 would be restricted as a result of drainage work due to the development of the Aviation Park.

  This water flows through a man made drain from a swamp located in the centre area of Lot 12 which allowed water to eventually reach the Serpentine River by way of natural drainage across a corner of the block.

  The owner indicated that this was purely a personal issue and was of no benefit to either their water supply or their property as the water was brackish.

  An undertaking was given that the engineering design would consider their position.

- Pilot responsibilities when operating from the airfield (Issue 2.6)

  The requirements for all pilots to comply with CAA operating standards, rules and regulations, and the conditions of the aerodrome operating manual were explained in detail and owners were advised of their access to the CAA and RACWA in regard to any pilot action that they considered unusual or causing concern.

  Two examples were quoted and investigations by the Chief Instructor of the RACWA indicated that they were both local pilots in privately owned aircraft.

  Contact with the pilots concerned was made by the Chief Flying Instructor of the RACWA advising the concern expressed and requesting that consideration of the residents concerns should be paramount at all times.

- Training student pilots (Issue 2.7).

  This issue was raised as a result of an article in a local newspaper.

  Following an explanation of student training methods and regulations this issue did not remain a concern to residents except the owner noted in 2.1.

- The advent of jet airliners (Issue 2.8).

  As with many rumours that had been circulating in the area the question of jet airliners was raised with regard to night curfews.

  It was pionted out that such aircraft were not able to use the facility and that CAA regulations would profibit any such movements.

  It was advised that the proposed airfield development provided for light aircraft only.

- Compatability of piggery and proposed resort (Issue 2.9)

  This issue was raised from the point of view that given a certain set of meteorological conditions the smell from the piggery might reach the resort and as a result offend persons not used to such rural odours causing pressure on the piggery to alter procedures and waste disposal methods.

  The Resort developer and Manager have indicated that this possibility had been considered in the initial stages of planning and following a study of wind directions and strengths over the last 25 years in the area it was found that such an occurrence would be rare due to the infrequency of the direction of the wind and the velocity needed for the odours to reach the resort.

  The Resort developers have indicated that they see no requirement for the piggery to change its modus operandis and did not consider that the piggery would be disadvantaged as a result of the Resort development.

  The resort management indicated that the marketing and promotion of the Aviation Park was to have a heavy emphasis on the rural environment in which it was being established.

  In discussions with the Management of the Piggery it was indicated that there could be mutual benefits in the use of waste water from the piggery for ground reticulation.

5. Conclusion

The owners/residents within the area of study, with one exception regarded the proposed Aviation Park development in a favourable light.

It is proposed to continue liaison with the residents in the area to identify any areas of concern that may subsequently arise.

APPENDIX 6

EPA BULLETIN 374
A GUIDE TO WETLAND MANAGEMENT IN PERTH - QUESTIONNAIRES

BROAD DEPRESSION
MID-WAY ALONG EASTERN BORDER OF LOT 12

2.2.2 Part 1B: Seasonal and episodic wetlands with poorly defined boundaries

i Environmental geology classification

Does the wetland occur on the Quindalup Dunes or on a geological unit confined to a river/estuary floodplain?

YES	Score	5	
(NO)	Score	1	
	Score		[1]

Source: Refer to 1:50,000 Environmental Geology Series (see Gozzard 1982).

Management Notes: Geological origin is one of the bases for wetland classification systems. In the metropolitan area, wetlands within these geological units are rare.

ii Adjacent wetlands

Are there wetlands within a 2km radius?

(YES)	go to question iii		
NO	Score	3 — go to question (iv)	
	Score		[ ]

Source : Aerial photos.

Management Notes: Refer to question (iii).

iii Habitat diversity

Is the composition and structure of the vegetation significantly different to that found at nearby wetlands?

YES	Score	3	
(NO)	Score	1	
	Score		[1]

Source: Refer to question (iv) for a list of habitat types. Use aerial photos and field visits.

iv Habitat type

Using the list below score one for each habitat type represented (maximum score 10).

a Vegetation over 0.1 hectare in area.

- large paperbarks (>2.5m tall) in dense clumps
- low thickets (ie <2.5m tall). These are often *Melaleuca, Astartea* or *Kunzea* spp
- paperbark fringe
- fringing rushes and sedges (often *Baumea, Juncea* spp)

89 - 70%	Score	6	
69 - 60%	Score	4	
59 - 50%	Score	2	
<50%	Score	1	
	Score		[ ]

Source: Aerial photos.

Management Notes: Native vegetation has a beneficial effect on water quality and aesthetics and is essential for wetland fauna. A clear management objective for all wetlands should be to ensure there is vegetation cover where it would normally occur. Limited clearing may be acceptable at some sites if management procedures ensure that weed invasion is controlled and applied nutrients are prevented from leaching into the ground water or reaching the wetland through surface flow.

2.2.2 Part 1B: Seasonal and episodic wetlands with poorly defined boundaries

i Environmental geology classification

Does the wetland occur on the Quindalup Dunes or on a geological unit confined to a river/estuary floodplain?

YES	Score	5	
(NO)	Score	1	
	Score		[1]

Source: Refer to 1:50,000 Environmental Geology Series (see Gozzard 1982).

Management Notes: Geological origin is one of the bases for wetland classification systems. In the metropolitan area, wetlands within these geological units are rare.

ii Adjacent wetlands

Are there wetlands within a 2km radius?

(YES)	go to question iii		
NO	Score	3 — go to question (iv)	
	Score		[ ]

Source : Aerial photos.

Management Notes: Refer to question (iii).

iii Habitat diversity

Is the composition and structure of the vegetation significantly different to that found at nearby wetlands?

YES	Score	3	
(NO)	Score	1	
	Score		[1]

Source: Refer to question (iv) for a list of habitat types. Use aerial photos and field visits.

iv Habitat type

Using the list below score one for each habitat type represented

(maximum score 10).

a Vegetation over 0.1 hectare in area.

- large paperbarks (>2.5m tall) in dense clumps
- low thickets (ie <2.5m tall). These are often *Melaleuca*, *Astartea* or *Kunzea* spp
- paperbark fringe
- fringing rushes and sedges (often *Baumea*, *Juncea* spp)

- fringing *Typha* (bullrush)
- samphire or saltmarsh
- extensive inlake beds of *Typha* or other rushes
- scattered dense clumps of rushes or sedges

b Other habitats

⊙ flooded grassland in winter/spring
- mud flats or seasonally dry open water
- islands — natural or human made
- fringing woodland or heath (eg eucalyptus nodes or non-wetland species)
- permanent **shallow** open water < 50cm deep
- permanent **deep** open water > 50cm deep

Score 1/2 point for
- scattered paperbarks

⊙ scattered rushes

Score [1.5]

Source: Field visit and aerial photos.

Management Notes: The composition, density and structure of the vegetation around a wetland has a major influence on the size and diversity of bird and other animal populations. The more complex the vegetation associations, the greater the habitat diversity.

v Drainage

Are there drains directing water into or out of the wetland?

(YES) Score 0
NO Score 5
Score [0]

Source: Field inspection and visit to local government authority.

Management Notes: Surface water run-off entering wetlands via drains is often polluted. Nutrient inputs from this source should ideally be monitored for several years before determining the most appropriate means of managing algal and insect problems.

vi Area of wetland modified

What proportion of the wetland, within boundaries taken as 50m from the edge of the inundated area, has been modified by landfill, paving, cultivated gardens/playing fields, irrigated agriculture, grazing, weed invasion, mining etc?

0 - 10% Score 5
11 - 20% Score 4
21 - 30% Score 3
31 - 40% Score 2
(> 40%) Score 1
Score [1]

Source: Aerial photos and maps.

Management Notes: See question (vii)

vii Native vegetation buffer

What percentage of the wetland perimeter has a buffer of native vegetation 50m or wider along it?

100 - 90% Score 5
89 - 80% Score 4
79 - 70% Score 3
69 - 60% Score 2

59 - 50%	Score	1
< 50%	Score	0
	Score	[0]

Source: Aerial photos.

Management Notes: Native vegetation has a beneficial effect on water quality and aesthetics and is essential for wetland fauna. A clear management objective for all wetlands should be to ensure there is vegetation cover where it would normally occur. Limited clearing may be acceptable at some sites if management procedures ensure that weed invasion is controlled and applied nutrients are prevented from leaching into the ground water or reaching the wetland through surface flow.

Total Score 4.5

2.3 Human use questionnaire

i Aesthetics

Does the wetland possess any of the following attributes? (score appropriately)

Little, if any, artificial noise	Score	2
Understorey mostly intact	Score	2
Few, or no, roads or buildings obvious from wetland	Score	2
Steep ridge visible as part of the scenery	Score	1
Ridge accessible giving view of wetland	Score	1
Wetland is a lake and open water easy to view	Score	1
✓ A section of wetland exists where few people visit	Score	1
	Score (total of above)	[1]

Source: Field survey.

Management Notes: A management plan should try to ensure that these attributes are preserved or enhanced by proposed developments.

ii Historical and archaeological features

Does the wetland have any of the following historical or archaeological features?

- registered Aboriginal relics or sacred sites
- pioneer relics/operations
- National Estate/Trust listings

If two or more (of the above)	Score	5
If one	Score	3
✓ Otherwise	Score	0
	Score	[0]

Source: Field survey, local government authoritys, National Trust, WA Museum — Department of Aboriginal Sites.

Management Notes: Strategies for the protection and/or preservation of historical and archeological features should be clearly defined in the management plan for the wetland.

iii Security of wetland

What is the current vesting of the land containing the wetland ?

A Class Reserve for conservation and recreation or Metropolitan Region Scheme reserve for Parks and Recreation owned by the Department of Planning and Urban Development or local government authority	Score	5

Other class of reserve — vested System Six recommendation unvested or on private property	Score	3	
Other class of reserve — unvested	Score	2	
Other (eg private or vacant Crown land)	Score	1	
	Score		[1]

Iv Protection groups

Does the wetland have active protection groups?

One or more	Score	5	
No groups	Score	5	
	Score		[5]

v Passive recreation

Is the wetland used for any of the following passive recreation activities?

If yes, score 1 for each

- nature study/bird watching
- education (school or other educational interest within 500m)
- picnic and /or barbecue facilities
- conservation of flora (refer to maps)
- conservation of fauna (refer to maps)
- protection and preservation of other attributes
- recognised research site
  - — biological
  - — archaeological
  - — other
- recognised tourist venue

Score [0]

Source: Field surveys, maps, road directories, State and local government department and residents.

Management Notes: Damage such as trampling, erosion and destruction of vegetation should be noted during the field visit.

vi Active recreation

Is the wetland used for any of the following active recreational activities? If yes, score 1 for each.

- walking/jogging or cycling
- horse riding
- trail bike riding
- playground
- sports grounds
- model boats
- golf course
- canoeing/rowing
- power boating/skiing
- swimming

Score [0]

Source: State and local government recreation departments.

Management Notes: Damage from current activities should be recorded during the field survey and reported to the appropriate authority/s.

vii Other human uses

Is the wetland used for any of the following purposes? (Score 1 for each)

- agricultural activities (grazing, horticulture etc)
- mining (check for mining leases)
- existing/proposed service corridors (SECWA, roads, etc)
- water supply
- proposed urban/housing use
- private purposes other than described above

Score [1]

Source: Field survey, maps and State and local government departments.

Management Notes: The compatibility of the above activities with conservation values should be considered during the formulation of a management plan. It may not be practical to achieve all management objectives, and land use priorities will have to be decided.

Total Score 8

2.4 Supplementary questionnaire

This questionnaire is used to determine the most appropriate management category for a wetland where the natural attributes and human use score falls in the "transition zones" in the graph in Appendix 6.

If the answer is YES in question i (below) the wetland should be moved to the management category to the right.

If NO, move to left.

If the answer to either ii or iii is YES, move upwards; if NO move downwards.

i Species rarity

Are rare species of animals or plants present or are there communities represented which have a limited distribution?

Source: Department of Conservation and Land Management, local government authorities, conservation groups, literature searches.

Management Notes: Wetlands supporting rare and endangered species should be given priority when allocating resources for the formulation of management plans and implementation of field works.

ii Effect on land values

Does the wetland significantly enhance real estate values and land rates around it? ie, does the wetland add more than 10% to the value of nearby houses?

Source: local government authoritys, estate agents.

Management Notes: The enhancement of real estate values is a legitimate reason for increased expenditure on the active management of a wetland.

iii Human use

Do more than 100 people visit the wetland each week?

Source: Extended field surveys, State and local government recreation departments.

Management Notes: This question provides a good measure of the need for human use management.

BROAD DEPRESSION ALONG
MID-WEST PORTION OF NORTHERN BOUNDARY OF LOT 12

2.2.2 Part 1B: Seasonal and episodic wetlands with poorly defined boundaries

i Environmental geology classification

Does the wetland occur on the Quindalup Dunes or on a geological unit confined to a river/estuary floodplain?

YES	Score	5
(NO)	Score	1
	Score	[1]

Source: Refer to 1:50,000 Environmental Geology Series (see Gozzard 1982).

Management Notes: Geological origin is one of the bases for wetland classification systems. In the metropolitan area, wetlands within these geological units are rare.

ii Adjacent wetlands

Are there wetlands within a 2km radius?

(YES)	go to question iii	
NO	Score	3 — go to question (iv)
	Score	[ ]

Source : Aerial photos.

Management Notes: Refer to question (iii).

iii Habitat diversity

Is the composition and structure of the vegetation significantly different to that found at nearby wetlands?

YES	Score	3
(NO)	Score	1
	Score	[1]

Source: Refer to question (iv) for a list of habitat types. Use aerial photos and field visits.

iv Habitat type

Using the list below score one for each habitat type represented
(maximum score 10).

a Vegetation over 0.1 hectare in area.

- large paperbarks (>2.5m tall) in dense clumps
- ⊙ low thickets (ie <2.5m tall). These are often *Melaleuca*, *Astartea* or *Kunzea* spp
- paperbark fringe
- fringing rushes and sedges (often *Baumea*, *Juncea* spp)

- fringing *Typha* (bullrush)
- samphire or saltmarsh
- extensive inlake beds of *Typha* or other rushes
- ⊙ scattered dense clumps of rushes or sedges

b Other habitats

- ⊙ flooded grassland in winter/spring
- mud flats or seasonally dry open water
- islands — natural or human made
- fringing woodland or heath (eg eucalyptus nodes or non-wetland species)
- permanent **shallow** open water < 50cm deep
- permanent **deep** open water > 50cm deep

Score 1/2 point for

- scattered paperbarks
- scattered rushes

Score [3]

Source: Field visit and aerial photos.

Management Notes: The composition, density and structure of the vegetation around a wetland has a major influence on the size and diversity of bird and other animal populations. The more complex the vegetation associations, the greater the habitat diversity.

v Drainage

Are there drains directing water into or out of the wetland?

YES	Score	0
(NO)	Score	5
	Score	[5]

Source: Field inspection and visit to local government authority.

Management Notes: Surface water run-off entering wetlands via drains is often polluted. Nutrient inputs from this source should ideally be monitored for several years before determining the most appropriate means of managing algal and insect problems.

vi Area of wetland modified

What proportion of the wetland, within boundaries taken as 50m from the edge of the inundated area, has been modified by landfill, paving, cultivated gardens/playing fields, irrigated agriculture, grazing, weed invasion, mining etc?

0 - 10%	Score	5
11 - 20%	Score	4
21 - 30%	Score	3
31 - 40%	Score	2
(> 40%)	Score	1
	Score	[1]

Source: Aerial photos and maps.

Management Notes: See question (vii)

vii Native vegetation buffer

What percentage of the wetland perimeter has a buffer of native vegetation 50m or wider along it?

100 - 90%	Score	5
89 - 80%	Score	4
79 - 70%	Score	3
69 - 60%	Score	2

(59 - 50%)	Score	1	
< 50%	Score	0	
	Score		[1]

Source: Aerial photos.

Management Notes: Native vegetation has a beneficial effect on water quality and aesthetics and is essential for wetland fauna. A clear management objective for all wetlands should be to ensure there is vegetation cover where it would normally occur. Limited clearing may be acceptable at some sites if management procedures ensure that weed invasion is controlled and applied nutrients are prevented from leaching into the ground water or reaching the wetland through surface flow.

Total Score 12

2.3 Human use questionnaire

i Aesthetics

Does the wetland possess any of the following attributes? (score appropriately)

Little, if any, artificial noise	Score	2	
Understorey mostly intact	Score	2	
Few, or no, roads or buildings obvious from wetland	Score	2	
Steep ridge visible as part of the scenery	Score	1	
Ridge accessible giving view of wetland	Score	1	
Wetland is a lake and open water easy to view	Score	1	
✓ A section of wetland exists where few people visit	Score	1	
	Score (total of above)		[1]

Source: Field survey.

Management Notes: A management plan should try to ensure that these attributes are preserved or enhanced by proposed developments.

ii Historical and archaeological features

Does the wetland have any of the following historical or archaeological features?

- registered Aboriginal relics or sacred sites
- pioneer relics/operations
- National Estate/Trust listings

If two or more (of the above)	Score	5	
If one	Score	3	
✓ Otherwise	Score	0	
	Score		[0]

Source: Field survey, local government authoritys, National Trust, WA Museum — Department of Aboriginal Sites.

Management Notes: Strategies for the protection and/or preservation of historical and archeological features should be clearly defined in the management plan for the wetland.

iii Security of wetland

What is the current vesting of the land containing the wetland ?

A Class Reserve for conservation and recreation or Metropolitan Region Scheme reserve for Parks and Recreation owned by the Department of Planning and Urban Development or local government authority	Score	5

Other class of reserve — vested System Six recommendation unvested or on private property	Score	3	
Other class of reserve — unvested	Score	2	
Other (eg private or vacant Crown land)	Score	1	
	Score		[1]

Iv Protection groups

Does the wetland have active protection groups?

One or more	Score	5	
No groups	Score	5	
	Score		[5]

v Passive recreation

Is the wetland used for any of the following passive recreation activities?

If yes, score 1 for each

- nature study/bird watching
- education (school or other educational interest within 500m)
- picnic and /or barbecue facilities
- conservation of flora (refer to maps)
- conservation of fauna (refer to maps)
- protection and preservation of other attributes
- recognised research site
  - — biological
  - — archaeological
  - — other
- recognised tourist venue

Score [0]

Source: Field surveys, maps, road directories, State and local government department and residents.

Management Notes: Damage such as trampling, erosion and destruction of vegetation should be noted during the field visit.

vi Active recreation

Is the wetland used for any of the following active recreational activities? If yes, score 1 for each.

- walking/jogging or cycling
- horse riding
- trail bike riding
- playground
- sports grounds
- model boats
- golf course
- canoeing/rowing
- power boating/skiing
- swimming

Score [0]

Source: State and local government recreation departments.

Management Notes: Damage from current activities should be recorded during the field survey and reported to the appropriate authority/s.

vii Other human uses

Is the wetland used for any of the following purposes? (Score 1 for each)

- agricultural activities (grazing, horticulture etc)
- mining (check for mining leases)
- existing/proposed service corridors (SECWA, roads, etc)
- water supply
- proposed urban/housing use
- private purposes other than described above

Score [1]

Source: Field survey, maps and State and local government departments.

Management Notes: The compatibility of the above activities with conservation values should be considered during the formulation of a management plan. It may not be practical to achieve all management objectives, and land use priorities will have to be decided.

Total Score 8

2.4 Supplementary questionnaire

This questionnaire is used to determine the most appropriate management category for a wetland where the natural attributes and human use score falls in the "transition zones" in the graph in Appendix 6.

If the answer is YES in question i (below) the wetland should be moved to the management category to the right.

If NO, move to left.

If the answer to either ii or iii is YES, move upwards; if NO move downwards.

i Species rarity

Are rare species of animals or plants present or are there communities represented which have a limited distribution?

Source: Department of Conservation and Land Management, local government authorities, conservation groups, literature searches.

Management Notes: Wetlands supporting rare and endangered species should be given priority when allocating resources for the formulation of management plans and implementation of field works.

ii Effect on land values

Does the wetland significantly enhance real estate values and land rates around it? ie, does the wetland add more than 10% to the value of nearby houses?

Source: local government authoritys, estate agents.

Management Notes: The enhancement of real estate values is a legitimate reason for increased expenditure on the active management of a wetland.

iii Human use

Do more than 100 people visit the wetland each week?

Source: Extended field surveys, State and local government recreation departments.

Management Notes: This question provides a good measure of the need for human use management.

2.2.2 Part 1B: Seasonal and episodic wetlands with poorly defined boundaries

i Environmental geology classification

Does the wetland occur on the Quindalup Dunes or on a geological unit confined to a river/estuary floodplain?

YES	Score	5
(NO)	Score	1
	Score	[1]

Source: Refer to 1:50,000 Environmental Geology Series (see Gozzard 1982).

Management Notes: Geological origin is one of the bases for wetland classification systems. In the metropolitan area, wetlands within these geological units are rare.

ii Adjacent wetlands

Are there wetlands within a 2km radius?

(YES)	go to question iii	
NO	Score	3 — go to question (iv)
	Score	[ ]

Source : Aerial photos.

Management Notes: Refer to question (iii).

iii Habitat diversity

Is the composition and structure of the vegetation significantly different to that found at nearby wetlands?

YES	Score	3
(NO)	Score	1
	Score	[1]

Source: Refer to question (iv) for a list of habitat types. Use aerial photos and field visits.

iv Habitat type

Using the list below score one for each habitat type represented (maximum score 10).

a Vegetation over 0.1 hectare in area.

- large paperbarks (>2.5m tall) in dense clumps
- low thickets (ie <2.5m tall). These are often *Melaleuca, Astartea* or *Kunzea* spp
- paperbark fringe
- fringing rushes and sedges (often *Baumea, Juncea* spp)

- fringing *Typha* (bullrush)
- samphire or saltmarsh
- extensive inlake beds of *Typha* or other rushes
- scattered dense clumps of rushes or sedges

b Other habitats

- flooded grassland in winter/spring
- ⊙ mud flats or seasonally dry open water
- islands — natural or human made
- fringing woodland or heath (eg eucalyptus nodes or non-wetland species)
- permanent **shallow** open water < 50cm deep
- permanent **deep** open water > 50cm deep

Score 1/2 point for

- ◔ scattered paperbarks
- ⊙ scattered rushes

Score [2]

Source: Field visit and aerial photos.

Management Notes: The composition, density and structure of the vegetation around a wetland has a major influence on the size and diversity of bird and other animal populations.The more complex the vegetation associations, the greater the habitat diversity.

v Drainage

Are there drains directing water into or out of the wetland?

YES	Score	0
(NO)	Score	5
	Score	[5]

Source: Field inspection and visit to local government authority.

Management Notes: Surface water run-off entering wetlands via drains is often polluted. Nutrient inputs from this source should ideally be monitored for several years before determining the most appropriate means of managing algal and insect problems.

vi Area of wetland modified

What proportion of the wetland, within boundaries taken as 50m from the edge of the inundated area, has been modified by landfill, paving, cultivated gardens/playing fields, irrigated agriculture, grazing, weed invasion, mining etc?

0 - 10%	Score	5
11 - 20%	Score	4
21 - 30%	Score	3
(31 - 40%)	Score	2
> 40%	Score	1
	Score	[2]

Source: Aerial photos and maps.

Management Notes: See question (vii)

vii Native vegetation buffer

What percentage of the wetland perimeter has a buffer of native vegetation 50m or wider along it?

100 - 90%	Score	5
89 - 80%	Score	4
79 - 70%	Score	3
69 - 60%	Score	2

59 - 50%	Score	1	
(< 50%)	Score	0	
	Score		[0]

Source: Aerial photos.

Management Notes: Native vegetation has a beneficial effect on water quality and aesthetics and is essential for wetland fauna. A clear management objective for all wetlands should be to ensure there is vegetation cover where it would normally occur. Limited clearing may be acceptable at some sites if management procedures ensure that weed invasion is controlled and applied nutrients are prevented from leaching into the ground water or reaching the wetland through surface flow.

Total Score 11

2.3 Human use questionnaire

I Aesthetics

Does the wetland possess any of the following attributes? (score appropriately)

Little, if any, artificial noise	Score	2	
Understorey mostly intact	Score	2	
Few, or no, roads or buildings obvious from wetland	Score	2	
Steep ridge visible as part of the scenery	Score	1	
Ridge accessible giving view of wetland	Score	1	
Wetland is a lake and open water easy to view	Score	1	
✓ A section of wetland exists where few people visit	Score	1	
	Score (total of above)		[1]

Source: Field survey.

Management Notes: A management plan should try to ensure that these attributes are preserved or enhanced by proposed developments.

II Historical and archaeological features

Does the wetland have any of the following historical or archaeological features?

- registered Aboriginal relics or sacred sites
- pioneer relics/operations
- National Estate/Trust listings

If two or more (of the above)	Score	5	
If one	Score	3	
✓ Otherwise	Score	0	
	Score		[1]

Source: Field survey, local government authoritys, National Trust, WA Museum — Department of Aboriginal Sites.

Management Notes: Strategies for the protection and/or preservation of historical and archeological features should be clearly defined in the management plan for the wetland.

III Security of wetland

What is the current vesting of the land containing the wetland ?

A Class Reserve for conservation and recreation or Metropolitan Region Scheme reserve for Parks and Recreation owned by the Department of Planning and Urban Development or local government authority	Score	5

Other class of reserve — vested System Six recommendation unvested or on private property	Score	3	
Other class of reserve — unvested	Score	2	
Other (eg private or vacant Crown land)	Score	1	
	Score		[1]

Iv Protection groups

Does the wetland have active protection groups?

One or more	Score	5	
No groups	Score	5	
	Score		[5]

v Passive recreation

Is the wetland used for any of the following passive recreation activities?

If yes, score 1 for each

- nature study/bird watching
- education (school or other educational interest within 500m)
- picnic and /or barbecue facilities
- conservation of flora (refer to maps)
- conservation of fauna (refer to maps)
- protection and preservation of other attributes
- recognised research site
  - — biological
  - — archaeological
  - — other
- recognised tourist venue

Score [O]

Source: Field surveys, maps, road directories, State and local government department and residents.

Management Notes: Damage such as trampling, erosion and destruction of vegetation should be noted during the field visit.

vi Active recreation

Is the wetland used for any of the following active recreational activities? If yes, score 1 for each.

- walking/jogging or cycling
- horse riding
- trail bike riding
- playground
- sports grounds
- model boats
- golf course
- canoeing/rowing
- power boating/skiing
- swimming

Score [O]

Source: State and local government recreation departments.

Management Notes: Damage from current activities should be recorded during the field survey and reported to the appropriate authority/s.

vii Other human uses

Is the wetland used for any of the following purposes? (Score 1 for each)

- agricultural activities (grazing, horticulture etc)
- mining (check for mining leases)
- existing/proposed service corridors (SECWA, roads, etc)
- water supply
- proposed urban/housing use
- private purposes other than described above

Score [0]

Source: Field survey, maps and State and local government departments.

Management Notes: The compatibility of the above activities with conservation values should be considered during the formulation of a management plan. It may not be practical to achieve all management objectives, and land use priorities will have to be decided.

Total Score 8

2.4 Supplementary questionnaire

This questionnaire is used to determine the most appropriate management category for a wetland where the natural attributes and human use score falls in the "transition zones" in the graph in Appendix 6.

If the answer is YES in question i (below) the wetland should be moved to the management category to the right.

If NO, move to left.

If the answer to either ii or iii is YES, move upwards; if NO move downwards.

i Species rarity

Are rare species of animals or plants present or are there communities represented which have a limited distribution?

Source: Department of Conservation and Land Management, local government authorities, conservation groups, literature searches.

Management Notes: Wetlands supporting rare and endangered species should be given priority when allocating resources for the formulation of management plans and implementation of field works.

ii Effect on land values

Does the wetland significantly enhance real estate values and land rates around it? ie, does the wetland add more than 10% to the value of nearby houses?

Source: local government authoritys, estate agents.

Management Notes: The enhancement of real estate values is a legitimate reason for increased expenditure on the active management of a wetland.

iii Human use

Do more than 100 people visit the wetland each week?

Source: Extended field surveys, State and local government recreation departments.

Management Notes: This question provides a good measure of the need for human use management.