EAST OF JOONDALUP URBAN DEVELOPMENT PROJECT

PUBLIC ENVIRONMENTAL REVIEW

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PUBLIC ENVIRONMENTAL REVIEW

EAST OF JOONDALUP
URBAN DEVELOPMENT PROJECT

Swan Location 2579 Clarkson Avenue
and Lots 1 and 2 Flynn Drive
Neerabup

February, 1992

Prepared for:
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EAST OF JOONDALUP URBAN DEVELOPMENT PROJECT
PUBLIC ENVIRONMENTAL REVIEW

The Environmental Protection Authority (EPA) invites people to make a submission on this proposal.

The Public Environmental Review (PER) for the proposed Urban Development Project on Swan Location 2579 Clarkson Avenue and Lots 1 and 2 Flynn Drive, Neerabup has been prepared in accordance with Western Australian Government procedures. The report will be available for comment for 8 weeks beginning Monday 24th February, 1992.

Comments from government agencies and from the public will assist the EPA to prepare an Assessment Report in which it will make recommendations to the Government.

Following receipt of comments from government agencies and the public, the EPA will discuss the issues raised with the proponent and may ask for further information. The EPA will then prepare its assessment report with recommendations to Government, taking into account issues raised in the public submissions.

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 will be acknowledged.

DEVELOPING A SUBMISSION

You may agree or disagree, or comment on, the general issues discussed in the PER or with 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 proposal in the PER:

- 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 PER. If you discuss sections of the PER, 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.

Please indicate whether your submission can be quoted in part or full, by the EPA in its Assessment Report.

REMEMBER TO INCLUDE:

Your name, address and date.

THE CLOSING DATE FOR SUBMISSIONS IS: Monday 20th April, 1992

SUBMISSIONS SHOULD BE ADDRESSED TO:

The Chairman
Environmental Protection Authority
8th Floor 'Westralia Square'
38 Mounts Bay Road
PERTH WA 6000

Attention: Mr Garry Middle

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SUMMARY

1. Yatala Nominees Pty Ltd, Homeswest and the R&I Bank have produced a Development Plan for three large contiguous parcels of land presently zoned Rural, under both the Metropolitan Region Scheme (MRS) and the City of Wanneroo Town Planning Scheme No.1 - the District Planning Scheme (DPS). The land is located east of Joondalup, adjacent to Wanneroo Road, at the eastern fringe of the North-West Corridor.

The Development Plan proposes an extension and consolidation of urban land uses in this part of the North-West Corridor. The plan incorporates a predominance of residential land use, with complementary land allocations for:

- community purposes, neighbourhood centres and schools,
- public recreation and public open space,
- district commercial centre, and
- essential services.

The planned residential densities and proportional allocation of land areas for the purposes listed above are in accordance with current State and Local government planning policies and guidelines.

2. Acceptance of the Development Plan and implementation of the development proposal will occur, following amendments to both the MRS and the DPS, which will require support from the Department of Planning and Urban Development (DPUD) and the City of Wanneroo, and the approval of the Minister for Planning In addition, formal assessment with respect to environmental matters will be required from the Environmental Protection Authority (EPA), and the approval of the Minister for the Environment. The DPUD will consult other relevant Decision Making Authorities (DMA's) in the assessment of the proposal.

The Development Plan proposal has been determined to require environmental assessment at the level of 'Public Environmental Review'. This document has been prepared to satisfy that statutory requirement, and provides a description of the proposal and its benefits, the environmental characteristics of the development site, the projected environmental impacts of implementation of the proposal, and the management approaches that will be adopted to mitigate these impacts.

3. It is intended that the project site will be developed with a variety of land uses and residential lot sizes and densities, consistent with current planning policies. Proposed future land uses are summarised as follows;

- Residential areas developed as neighbourhood cells, with densities in general according with the R15 and R17.5 residential codes.
- A total of six primary school sites and one high school site.
- Commercial and community centres.
- Public open space totalling 10% of the total nett developable area, including space for a major district sports centre proposed by the City of Wanneroo.
- An efficient internal road system, and major arterial road linkages to population and employment centres to the south and west, consisting of an extension of Burns Beach Road (East West 7) and an eastern connection to this road, and an easterly upgraded Flynn Drive (East West 8).
- Services, including reticulated sewerage and water, electricity, gas and telecommunications.

The project area will be developed in a series of stages, commencing generally in the southern part of each land holding, and will be released over a period spanning approximately 10 years commencing in mid-1993, assuming approval of the present proposal.

4. The benefits to the community that will result from the project may be summarised as follows;

- Analysis by the DPUD of the demand for housing over the next thirty years, compared to the available supply of allotments, confirms that approximately 320,000 new homes will be required within the Metropolitan area within new urban areas. The present proposal will assist in meeting this demand whilst conforming with the principal planning criteria that are recognised for the Metropolitan area. Importantly, the efficient use of the land as is proposed, will assist in arresting the rate at which new land must be taken up for housing in the Metropolitan region in general.

- The physical suitability of the land for housing, its close location to existing services and the restriction of ownership to three large land parcels will assist in minimising development costs. These factors will also enable the early supply of a mix of housing types, which are needed to cater for a wide range of community requirements.

- The use of the land for urban development according to the proposed Development Plan, is consistent with the State Governments' Urban Expansion Policy and with current strategic planning for the north-west corridor. The consolidation of urban growth to the east of Wanneroo Road will greatly assist in the achievement of decentralisation objectives for the Joondalup Sub-Regional Centre which continues to develop fairly slowly due to it's location at the eastern extremity of it's present catchment.

- The coordinated development of such a significant parcel of land will facilitate the early establishment of the required community infrastructure, a situation which does not arise to the south. In this southerly area urban development was the preferred strategic planning objective, however ownership is highly fragmented, and development would take many years of planning and coordination.

- The available data indicates that the site does not support environmental resources which should be considered as absolute constraints to development, in the context of the importance of new housing needs in the Metropolitan Region. This is particularly apparent when considering many of the similar areas within the Metropolitan Region which although similarly suitable for development are known to possess significant environmental constraints.

- Importantly, during subdivision design and detailed planning, which will follow the Development planning phase, current environmental planning policies, guidelines and environmental management strategies will be incorporated to the greatest practical degree.

  As much of the existing natural vegetation as possible will be retained within Public Open Space (POS) and other land areas and will be managed appropriately. Natural vegetation will be retained on lots wherever engineering and building constraints allow. Engineering design and landscaping, where this occurs, will implement strategies for water conservation, and nutrient management for groundwater protection. The cooperation of future landowners and the local authority will assist in this regard.

The opportunity to implement current approaches to environmental planning and design on such a large scale, is a result of limited ownership of the land and the coordinated approach to development that is therefore achievable.

5. The site consists of three large contiguous lots totalling 829 ha, each of which is currently zoned Rural under the MRS, although the State Planning Commission (SPC) has initiated the rezoning of the land to Urban. Apart from one small area of horticultural land use, the site is presently undeveloped, although the southern half of the site has been cleared and used for grazing for many years. The site is surrounded by a mix of rural and semi-rural land uses typical of the outer Metropolitan area.

6. The site comprises elevated, gently undulating land which may be generally described as limestone and sand terrain. The site is well drained due to its soil type and elevation, but is flanked by lower lying land supporting wetlands, to both the east and west.

7. The site is underlain by good quality groundwater at an average depth of approximately 25m below surface. The principal local uses of groundwater are for irrigation and importantly, for wetland maintenance to the east and west of the site. To the east and north-east, public water supply and forestry are additional major uses.

8. The natural vegetation comprises *Banksia* and Jarrah-*Banksia* Woodland which is generally in good biological condition in the northern portion but has been reduced to scattered, degraded remnants elsewhere. The site is not known to support any declared rare or geographically restricted species of plant or animal. A review of relevant records of the distribution and habitat preference of declared rare or geographically restricted species that are known to the region, has indicated that none are likely to occur within the site due to the absence of suitable habitat.

The site's remaining vegetation has been identified as Karrakatta Central and South Vegetation Complex, which occurs in a band along the coast from the Pinjar area to south of Bunbury. Karrakatta Central and South Vegetation Complex is represented in eighteen existing or proposed System Six conservation reserves whose areas total 5,500 ha on the Swan Coastal Plain, and is also locally and regionally represented within private land.

9. The site does not contain any significant wetlands. However, regionally significant wetlands affected by System Six recommendations occur in adjacent land. Lake Joondalup (M7) and Lake Adams (M8) are the closest important wetlands to the site.

10. The local noise environment is normally dominated by agricultural machinery noise, road traffic and natural background noise within woodland and forest vegetation. Motor racing at local venues, is most audible within northern parts of the site where ambient noise levels may increase by 10-15 dB(A). The natural attenuation of noise over distance reduces the effect of racing noise further to the south where background noise can mask racing noise to inaudible levels. This is particularly so during the occurrence of prevailing south-westerly breezes.

11. The major environmental impacts resulting from development will be the removal of the natural vegetation and fauna habitats from the majority of the northern half of the site, as required by the development plan, and the changes that are likely to the average position of the water table.

In the context of the local historical trend of falling groundwater levels due to landuse, and future regional land use proposals involving further groundwater abstraction, the potential of this development proposal to increase local groundwater levels can be considered to have positive impact potential. The potential for Lake Adams and possibly Lake Joondalup to experience gradual water level increases over an extended period, is considered particularly beneficial, as is the potential increased local availability of groundwater for abstraction.

The project will be fully serviced by a reticulated sewerage system (which is crucial to groundwater management), and this will protect the groundwater from significant detrimental quality changes. Proposals to manage landscaping, fertilisation and irrigation practice will further assist in maintaining groundwater at acceptable quality.

It is also proposed to retain as much natural vegetation as practicable within public open space and other recreation areas, and as landscape areas within schools and community purposes areas where appropriate. This vegetation will be managed with the objective that its future viability is maximised. Natural vegetation reserves will include an area with identified anthropological significance related to the mythical presence of the Honey Possum, to meet the requirements of the traditional Aboriginal custodians of the site.

Measures to preserve the largest possible area of natural vegetation within the development area will assist in minimising the impact of implementing the proposal, but will require the ongoing assistance and cooperation of the City of Wanneroo, and future landowners.

12. At the detailed engineering design stage of the project, environmental management will be addressed through the adoption of water conservation measures. This will include stormwater handling and landscape design, and maximised retention of natural vegetation.

13. Environmental management during the construction and implementation stages of development will include;

- removal and replacement of topsoil,
- control of noise, dust and smoke nuisance potential,
- fuel storage management to prevent groundwater contamination,
- heavy vehicle traffic control,
- dieback control through the adoption of appropriate disease hygiene practices,
- exclusion of the construction contractor from areas where vegetation is to be preserved,

14. In the post development phase of the project, environmental management will focus on the correct management of recreation, habitat and cultural reserves for the protection of groundwater quality and to maintain the long term viability of natural vegetation and habitat.

15. The environmental impacts which will result from implementation of this proposal will be offset by the benefits which will derive for the community, through the achievement of strategic planning goals for housing and community infrastructure in the north-west corridor and the Metropolitan area in general.

1.0 INTRODUCTION

1.1 Description of the Land and the Development Proposal

Yatala Nominees Pty Ltd, Homeswest and The R&I Bank have jointly prepared a Development Plan to support an application to rezone three large contiguous parcels of Rural-zoned land at north Wanneroo, for Urban purposes. The land parcels are;

- Swan Location 2579, (379 ha)-Yatala Nominees Pty Ltd,
- Lot 2 Flynn Drive, (385 ha)-Homeswest, and,
- Lot 1 Flynn Drive, (65 ha)-R&I Bank.

The Environmental Protection Authority has determined that the Development Plan requires formal environmental assessment under Part IV of the Environmental Protection Act, 1986. This Public Environmental Review has been prepared to enable formal assessment to proceed.

Following the conferral of approval by the Minister for Environment, acceptance of the Development Plan and rezoning of the land to 'Urban' under the MRS, and rezoning of the land to 'Residential Development' under the DPS, subdivision plans will be prepared and submitted to the DPUD for approval, to enable the development programme to be implemented.

The land is located approximately 27 kilometres from the Perth Central Business District (CBD) and approximately six kilometres north of the Wanneroo townsite, as shown on Figure 1. The land is bounded on the western side by Wanneroo Road, Carramar Park and the Korzunski Memorial site, to the north by Flynn Drive, to the east by Pinjar Road and to the south by Clarkson Avenue. The total area of the three land parcels is 829 hectares.

The development site comprises elevated land that may be generally described as undulating sandy terrain with occasional low limestone outcrops. The site is well drained and does not contain any permanent surface water.

The southern half of the site has previously been cleared for agriculture. Apart from a small area of horticultural land use within Lot 1 Flynn Drive, the remainder of the northern part of the site is undeveloped and presently supports natural vegetation.

1.2 The Rationale for the Development

The need for this urban development proposal arises from the projected demand for new housing within the Metropolitan area, particularly within the north-west corridor. Current projections indicate that there will be a need to provide approximately 320,000 homes in new areas over the next thirty years.

The rapid development of urban land uses and the establishment of the necessary community infrastructure can proceed readily within this proposed development area. This is not the case in other nearby areas which are also earmarked for urban land uses. The limited ownership, the large size of the land parcel, and the ease with which servicing can be provided to and throughout the site, makes this parcel of land the most suitable for immediate urban development in the northern suburbs. Development of the site will be staged over a 10 year period, commencing as soon as Government approvals can be obtained.

The land can be developed with a minimum of earthworks, and as services such as sewerage, water, electricity and gas can be readily provided throughout the site, the servicing costs will be comparatively very low. As the site is composed of sand and generally free of surface rock and a high water table, the construction costs will also be comparatively low.

The site is well located in relation to present and planned employment and population centres and will be well served by transport services.

Current housing policy recognises the need to provide a greater choice in housing to cater for a wide range of community requirements, at affordable cost. These factors have been accommodated in the Development Plan.

The proposal to extend and consolidate urban land uses in this part of the North-West Corridor is fully consistent with the "Urban Expansion Policy Statement for the Perth Metropolitan Region", released by the State Government in November 1990 and will therefore assist in the achievement of strategic planning goals for the North-West Corridor and the Metropolitan Region.

1.3 The Statutory Approvals Process

A number of Government Authorities will be involved in the decision making process in the course of approving this proposal. These include;

- The State Planning Commission and the DPUD
- The City of Wanneroo,
- The Environmental Protection Authority,
- The Water Authority of Western Australia,
- The Main Roads Department.
- State Energy Commission of Western Australia

This document has the purpose of describing the proposal, the anticipated environmental impacts and environmental management proposals required to mitigate impact, to assist in the assessment process.

The Environmental Protection Act, 1986 requires that any development which has the potential to affect the environment must be assessed by the Environmental Protection Authority. One of four levels of assessment may be assigned to a proposal by the EPA. These are:

- Informal Review with Public Advice
- Consultative Environmental Review (CER)
- Public Environmental Review (PER)
- Environmental Review and Management Program (ERMP)

This proposal has been assigned a Public Environmental Review by the EPA, which is the second highest level of formal assessment. Following acceptance of this document by the EPA as suitable for public release, this PER is currently available for a period of 8 weeks during which submissions may be made regarding the proposal. At the conclusion of the public comment period the EPA will consider the proposal together with any public submissions. Public submissions are confidential, however the proponent will be asked to comment on any issues which are raised by the public, and summarised by the EPA.

When the assessment is completed, the EPA will prepare a report which will summarise the issues and state whether the project is environmentally acceptable and under what conditions. Anyone can appeal against the content of recommendations of an EPA assessment report.

Before a project may proceed, the Minister for Environment must give approval and will set conditions which must be met by the proponent. Only the proponent can appeal against Ministerial conditions which, when set, are legally binding.

2.0 PROJECT JUSTIFICATION

The need for this development proposal is described in this section, within the context of the planning strategies and policies for the Metropolitan Region which have been developed by the State Government to cater for the demand for new housing to accommodate the region's projected population growth. Both regional and local planning aspects of the proposal are addressed.

2.1 Regional Planning Aspects

The Perth Metropolitan Region has been one of the most rapidly growing areas in Australia during the last four decades, having consistently averaged between 2.0%-2.5% population growth each year. Planning, particularly for urban growth, has been a major task for Government.

The planning of the Metropolitan area was the subject of a study by Messrs Stephenson and Hepburn in the mid 1950's. In 1959 the Metropolitan Region Scheme Act was proclaimed and in 1960, the Metropolitan Region Planning Authority (MRPA) was formed. The Metropolitan Region Scheme (1963) defines the Development planning and principal land use components of the region.

In 1966, the MRPA commenced a review of the Metropolitan Region Scheme and developed the concept of corridor expansion and sub-regional centre development. The Corridor Plan for Perth was adopted by the MRPA in November 1970 and proposed a regional decentralisation of some central area functions to five sub-regional centres, most of which were located towards the extremities of the corridors as they then existed. A primary objective of the Corridor Plan was to avoid uncontrolled urban sprawl, by creating a city built along strong transport corridors which would provide easy access to employment, services and open space (DPUD, 1990a).

In 1987, the then State Planning Commission, which had superseded the MRPA, commenced a review of the Corridor Plan through an independent Review Group. The Review Group published a report (SPC, 1987) which considered the capability of the Metropolitan Region Scheme to cater for future growth, and identified a preferred strategy for amendment of the MRS, to accommodate this growth and change.

Following public review and submissions regarding the report and refinement of the proposed changes to the MRS, the Department of Planning and Urban Development published an explanatory document entitled "Planning for the 1990's-New Directions for the Perth Metropolitan Region" (DPUD, 1990a), and has recently issued an "Urban Expansion Policy Statement For Perth Metropolitan Region" (DPUD, 1990c) following the issue of this policy statement in draft form (DPUD, 1990b). Further consolidation of the planning proposals which are set out in these documents was achieved through the release of "Metroplan, A Planning Strategy for the Perth Metropolitan Area" (DPUD 1990d) and the North-West Corridor Structure Plan (DPUD, 1991a). This latter document was open for public comment for some 12 weeks. A further document entitled "Metropolitan Development Program 1991/92-1995/96", which confirmed planning strategy into a development program, was published by the Department of Planning and Urban Development in November of 1991.

These documents, and the strategies and policies they embody, set the regional planning agenda for the city, including the North-West Corridor, for the next thirty years. The Urban Expansion Policy and the proposal for changes to the MRS unequivocally confirm the strategic necessity of developing new urban land and facilities within the project site, as a short term planning priority.

To enable the rationale for the strategic approach to the accommodation of future growth in the North-West Corridor to be properly explained, the most important factors that have influenced planning are cited or summarised from DPUD (1990b) below. The areas which have been set out for additional urban development are shown on Figure 2, extracted from the Urban Expansion Policy Statement (DPUD, 1990c).

- Present projections of the Region's population growth suggest recent high levels of growth will be maintained in the foreseeable future. This is a result of high natural increase (an excess of births over deaths), and migration from overseas, other States and other regions within WA.

- The rate of growth in demand for housing is expected to rise faster than the growth in population, because the average size of families and the average number of people per dwelling are both expected to continue to decline. This means that an expected 60%-70% growth in population by 2021 would require a 100% increase in the number of dwellings.

- The most optimistic expectations indicate that about 80,000 new homes can be accommodated in established urban areas. At least 320,000 new homes will therefore be needed in new urban areas. Approximately 37,500 hectares, at a gross residential density of around nine homes per hectare, will be required in order to provide for residential needs alone within new expansion areas, with considerable further land being required for associated land uses.

- The Review Group and DPUD's evaluation of the principal strategic planning factors affecting the Region, led to the identification of sixteen general areas where urbanisation could most likely proceed within the next thirty years, and a further nine general areas where major issues would need to be resolved to allow urbanisation to occur within the next thirty years. These areas are listed in Table 1 and are shown in relation to the existing MRS on Figure 2. The principal planning criteria that were accounted for in delineating these areas are summarised below;

  - land suitability for development
  - the patterns of urbanisation that will best meet the needs of the growing region
  - the expected ease of developing the land, having regard to the viability of the scale of development
  - the availability of urban infrastructure (water supply, sewerage, transport network)
  - the physical and environmental constraints to urbanisation.

The proposed development site performs very favourably when its suitability for urbanisation is tested against these criteria and within the context of the overall planning requirements for the Region, during the next thirty years.

2.2 District and Local Planning Aspects

2.2.1 District Aspects

Urban development of the proposed site is also consistent with district and local planning objectives and will have a beneficial impact on future economic growth within the City of Wanneroo.

Table 1

Comparison of Potential Areas where Urban Development Could Proceed Within the Next Thirty Years

Location	Category A* (ha)	Category B* (ha)
N.W. Corridor		
Coastal	3,250	5,800
East Wanneroo Road	2,700	800
N.E. Corridor		
West Swan	3,010	2,200
Beechboro	880	-
Middle Swan	2,200	-
Foothills		
Swan	250	-
Mundaring	100	-
Kalamunda	450	270
Gosnells	160	-
S.E. Corridor		
Canning	370	-
Gosnells	1,150	700
Armadale	810	-
Serpentine/Jarrahdale	-	4,830
S.W. Corridor		
Cockburn	1,200	1,000
Kwinana	270	500
Rockingham	1,800	2,800
TOTAL	**18,600**	**18,900**
TOTAL (CATEGORIES A & B)	**37,500 ha**	

Source: DPUD (1990c)

* Category A - Areas most suited for urban development within the next thirty years.

* Category B - Areas currently constrained by major issues requiring resolution to enable urban development within the next thirty years.

The urbanisation proposal will greatly assist in the achievement of the 'decentralisation' objectives that led to the establishment of the Joondalup Sub-Regional Centre, which presently continues to develop fairly slowly.

One of the major causes of this slow rate of development is the location of the 'Centre' on the eastern extremity of the North-West Corridor, which is the edge of the catchment area which the 'Centre' was foreseen as servicing in respect to most regional functions. The significant economic impact of this imbalance has been one of the major factors that has, to date, resulted in the paucity of commercial development which has been attracted to the 'Centre'. The development of the substantial area of land on the eastern side of the Joondalup Centre will significantly redress the locational imbalance of Joondalup, and will assist in ensuring the intended economic growth of the 'Centre'.

The 1987 'Review Group' report and the Urban Expansion Policy both identify a proposed major new urban area to the east of Wanneroo Road (Figure 64 , SPC, 1987; Map 2 DPUD, 1990) which can be easily serviced and could have accommodated a maximum of 80,000 people, although the extent of this area has been substantially reduced, following consultation with the local community and the City of Wanneroo. The subject land forms part of the northern area of land proposed for urban purposes, the importance of which is further emphasised by the reduction of the area to the south.

It is recognised by the Review Report that the southern portion of the area (to the south of the present site) has undergone considerable subdivision, and that the associated intensified land uses and capital improvement, will inevitably make it difficult to consolidate a sufficiently large area for economic urban development. The result is that much of the southern part of this area is likely to be unavailable for urban development in the foreseeable future.

The 'Review Group' report also recognises that the converse applies in the northern area with the result that the subject land, which is comprised of only three substantial land holdings, is eminently suitable for new urban development in the short to medium term.

The area shown in the report is recommended on the assumption that any such development would be staged over the next ten years. The early commencement of the process of urbanisation on the eastern side of Wanneroo Road is further supported by the fact that the Water Authority of WA has included the subject land within its servicing projections, and by the

latest Perth Metropolitan Region Residential Land Availability Survey prepared by the Land Analysis & Monitoring Branch of DPUD, which shows the subject land as being available for development from 1990.

The comprehensive planning and co-ordinated development of such a significant parcel of land by only three separate developers will result in a core of urban development which will facilitate the early economic development of the required community infrastructure, a situation which would not be likely to arise to the south of the site where the land ownership is so fragmented, and will also support the growth of Joondalup.

The developing core area will therefore act as a catalyst for the encouragement of future growth to the south, in accordance with the Urban Expansion Policy Statement.

2.2.2 Local Planning Aspects and Current Zonings

The subject land is zoned "Rural" under the City of Wanneroo Town Planning Scheme No. 1, as is the land immediately to the north and south of the site.

The land immediately to the North-West of the site is zoned "Special Rural" under the Scheme, and has been developed as the Carramar Park estate. The area to the east of the site (south of Neaves Road) is also zoned "Special Rural" and is known as the Lake Adams Special Rural Zone. The area to the north of Neaves Road is set aside as State Forest. Zoning is further described in Section 3.3.

Land to the west of the site is currently zoned Rural and is affected by proposals for the Yellagonga Regional Park and for expansion of Neerabup National Park.

2.3 Summary of Benefits to the Community

The benefits of rezoning and developing the proposed site for urban land use are summarised as follows;

- Available data indicates that the site does not support environmental resources which should be considered as absolute constraints to development, in the context of the

importance of the need for housing in the Metropolitan Region. This is particularly apparent when considering many of the similar areas within the Metropolitan Region which, although similarly suitable for development, are known to possess more significant environmental constraints.

- The projected groundwater effects of the proposal, particularly in relation to its potential to increase the average level of the local unconfined water table, are anticipated to be of benefit to local wetlands, (particularly Lake Adams), in comparison to other long-term regional land use proposals, most of which will potentially lower the water table (see Section 5.1.2).

- The site can be simply and economically provided with utility and communication services, and most importantly with regard to groundwater and wetland protection, can be readily connected to the reticulated sewerage system. These factors are particularly relevant to, and will consolidate, the Region's ability to provide affordable housing land into the next century.

- The Development Plan and intended detailed planning provisions feature a limited amount of medium-density housing in appropriate locations throughout the site, which will assist in the achievement of the objectives of making efficient use of new urban land, and reducing the rate at which future urban growth extends from the present built-up areas.

- The establishment of some medium-density housing at this proposed location is consistent with the desire for this type of development to occur in close proximity to major regional centres and to the new Northern Suburbs Rail Line. Present projections of the development schedule that will be achieved for the new rail line are for extension to Joondalup to be completed during the early 1990's and to Burns Beach Road which aligns closely with the development schedule for this project .

- The site is also exceptionally well located in relation to the Mitchell Freeway and will allow access to the CBD via the regional road network.

- Development planning for the site directly incorporates a range of housing types to cater

for a wide range of social requirements. Through the adoption of current planning policies for neighbourhood centres and public open space, this housing development will provide a high level of neighbourhood amenity.

It is concluded that the proposed urban development of the site is necessary to assist in the provision of affordable housing for the rapidly growing population of the Perth Metropolitan Region. The site performs very favourably when its suitability for urbanisation is measured against accepted planning criteria. Development of the site as new urban land is also consistent with district and local planning objectives, and will have a beneficial impact on the future economic growth of the City of Wanneroo.

In combination, the relatively low inherent land cost, the aesthetic attractions of the land, the close proximity to Joondalup Centre, the anticipated minimal development costs and the ease of provision of services, make the project an extremely viable and attractive opportunity to provide affordable and desirable housing, which will greatly assist the Government's land supply and housing objectives, particularly in the short term, while other more constrained areas undergo planning.

These benefits to the future development of the Metropolitan Region must be carefully considered in comparison to the environmental implications of urbanising this site, not only in isolation, but also in contrast to alternative major potential sites for urbanisation, for which the overall balance of strategic planning benefits compared to environmental costs may be considerably less favourable.

3.0 DESCRIPTION OF THE EXISTING ENVIRONMENT

This section of the report presents a description of the environmental characteristics of the proposed development site from both local and regional perspectives, to provide a basis for the description and assessment of the environmental impacts given in Section 5.0.

3.1 Physical Environment

3.1.1 Topography

The site lies within a belt of relatively elevated limestone ridge and undulating sandy terrain which is aligned parallel to the present coastline and is flanked to both the east and west by lower-lying land. These low-lying areas support a series of wetlands including Lakes Joondalup and Neerabup to the west, and Lake Adams, Mariginiup Lake and Little Coogee Swamp to the east.

Figure 3 shows that the land elevation within the site varies from minimum levels of approximately 25 - 30m Australian Height Datum (AHD) along the western boundary and 40 - 50m AHD along the eastern boundary, to maximum levels of 70 - 80m AHD on the ridge crests in the central northern sector of the site.

3.1.2 Landform and Soils

The site is located within the Spearwood Dune system, which consists of limestone overlain by sand. Landform mapping reported by the Department of Conservation and Environment (1980) divides the Spearwood Dunes into two landform types, being:

- Karrakatta Landform - undulating landscape with deep yellow sands over limestone, and
- Cottesloe Landform - low hilly landscape with shallow brown sands over limestone.

Maps presented by DCE (1980) describe the site as entirely of Karrakatta Landform. Although the site is typical of the general description of Karrakatta Landform noted above, some limited limestone occurs at or very close to the surface in the central parts of Lot 2579.

The soil profile through the site varies in terms of the colour and depth of soil overlying the limestone. In general, soil profiles comprise a thin grey-brown surface layer containing accumulated organic matter, underlain by yellow sands. The thickness of the surface sands is greater in the northern and eastern parts of the site, whilst limestone occurs at comparatively shallow depth in the western and central-southern sectors.

3.1.3 Surface Water Hydrology

Rainfall readily infiltrates the sand profile and there are no active natural water courses, surface drains or wetlands with surface water within the site. Permanent and seasonal wetlands, which are surface expressions of shallow groundwater, occur in land surrounding the site. These are discussed in the following section.

3.1.4 Groundwater Hydrology

3.1.4.1 Regional Hydrogeology

The major groundwater resources north of Perth occur in three specific geological units. These are the superficial formations, and the Yarragadee and Leederville formations (Water Authority, 1986, see Figure 4). The broad groundwater mound which has developed in the superficial formations north of Perth is referred to as the Gnangara Mound. The superficial formations of the Gnangara Mound consist of variable sequences of sand, limestone, silt and clay. In the vicinity of the site, groundwater flow is predominantly in a south-westerly direction away from the mound's centre.

The configuration of the groundwater table throughout the mound is a subdued reflection of the regional topography (Water Authority, 1986). The height of the water table reduces from 70m AHD at the centre of the mound to 0m AHD at the coast. Throughout the mound, wetlands have developed where depressions in the land surface fall to lower levels than the groundwater table. The wetlands are maintained by groundwater inflow and undergo seasonal variations in water level corresponding to fluctuations in the elevation of the water table and the direct influence of rainfall and evaporation.

The groundwater resource of the Gnangara Mound is maintained (recharged) primarily by rainfall. The amount of rainfall which becomes groundwater recharge is dependent upon:

- the amount, intensity and duration of rainfall

- interception (by leaves) and evapotranspiration (plant uptake and loss) by vegetation
- soil characteristics and the depth to the water table.

Recharge to the mound is also influenced by human activities which include:

- silvicultural (tree farming) land use under the care of CALM
- abstraction by the Water Authority of Western Australia (WAWA) for public water supply
- clearing of vegetation
- irrigation of playing fields, lawns and gardens
- on-site domestic effluent disposal
- abstraction for private water supply principally supporting horticulture
- urbanisation and drainage from impervious surfaces.

3.1.4.2 Groundwater Hydrology of the Site

The site is located approximately ten kilometres south-west of the centre of the Gnangara Mound (Figure 5).

The highest recorded water table heights for the site and environs are illustrated as groundwater contours on Figure 6 and range between 46m AHD at the eastern boundary to 19m AHD at the western boundary. The groundwater flows across the site in a south-westerly direction, generally at right-angles to the contours. A steep change in the groundwater hydraulic gradient that occurs within the eastern sector of the site is believed to mark a groundwater cascade where groundwater moves through limestone caves (Water Authority, 1986).

The depth of the water table below the ground surface varies in response to the topographical elevation of the site. It is greatest beneath the limestone ridges, where it is up to 40m below the surface. Beneath some of the lower lying areas, the water table is within approximately 4m of the ground surface.

Although there are no permanent wetlands on the site, a depression located adjacent to Pinjar Road near the north eastern corner of the site is fringed by *Melaleuca's* (paperbarks), which indicates that this area may at one time have been seasonally moist prior to a gradual lowering of the water table due to changing land uses surrounding the area. In the south-eastern

corner of the site there are remnant *Melaleuca* and *Eucalyptus* trees that fringe the seasonal wetland that is located immediately to the south of Clarkson Road. This area has been cut off from the wetland by the construction of Clarkson Road.

3.1.4.3 Adjacent Wetlands

Topographically low-lying land located east, north-east and west of the site supports a series of wetlands.

The well defined interdunal depression located within Cottesloe Landform to the west of the site supports a series of major linear, deep, permanent wetlands. Lake Joondalup is the closest of these to the site whilst Lake Neerabup occurs further to the north.

To the east and north-east of the site within the Bassendean Dune Landform, a series of shallow circular wetlands occur within low-lying land including Lake Pinjar, Lake Adams, Lake Mariginiup and Lake Jandabup.

3.1.4.4 Water Balance

The water balance characteristics of the proposed development site are reviewed in Appendix A. It is estimated that the average annual volume of nett aquifer recharge that presently occurs within the site is in the range 1,538 ML (Megalitre, or 1 million litres) and 3,339 ML. The range in these estimates is due to the range in recharge coefficients[1] for *Banksia* woodland and pasture which have been developed by different scientific researchers, and incorporated in the calculations. Groundwater abstraction from the proposed development site is estimated to presently total approximately 250 ML per annum, equivalent to 7.5 - 16.2% of the estimated nett recharge.

3.1.4.5 Groundwater Quality

There are no directly useful groundwater quality data applicable to the site. However, it is anticipated that the **existing** quality of groundwater underlying the site would be poorer than that which typically occurs within natural bushland, due to the following local influences:

[1]Recharge co-efficient - a figure representing the proportion of rainfall which becomes aquifer recharge.

- Salinity levels may be elevated by evaporation and evapotranspiration from adjacent wetlands "upgradient" of the site.

- Nutrient levels may be elevated from fertiliser additions to adjacent landholdings, including:
  - Floriculture within the northern sector of the site;
  - Horticulture to the east of the site;
  - the Wanneroo Public Golf Course, located adjacent to the north eastern corner of the site;
  - the Gnangara Pine Plantation (State Forest 65) to the east of the site;

- Nutrient contamination may occur from a piggery located approximately 1 km east of the site's north eastern boundary, and from an unsewered Special Rural subdivision near Lake Adams.

3.2 Biological Environment

3.2.1 General

The site is located on the northern fringe of the current Metropolitan Area, and has experienced both direct and indirect environmental changes due to previous land use in the area.

At the present time, general aspects regarding the site's biological condition may be summarised as follows:

- Location 2579, comprising the southern section of the site, has been almost completely cleared and used for livestock grazing. Three remnant areas of native vegetation remain. The area has had some limited replanting in a scattered "parkland" format using Australian native plants. Regrowth of certain of the former indigenous species has also occurred throughout the site, but the resultant vegetation is variable in stature and density and consists of only a limited number of species, principally understorey shrubs which tend to proliferate following overstorey canopy removal. Regrowth species include *Acacia sp., Hibbertia spp.* and *Jacksonia spp.*.

- Lot 2 in the northern part of the site supports native vegetation that is generally in good biological condition. A series of tracks traverse the area and human activities such as horse riding, woodcutting and illegal rubbish dumping are evident.

- Approximately 40% of Lot 1 has been cleared and is used for intensive horticultural activities. The remainder of Lot 1 continues to support native vegetation, most of which is in good biological condition. The northern portion of the remaining vegetation has been affected by woodcutting and rubbish dumping and contains a number of vehicle tracks.

Most of the land surrounding the site has now been developed or is committed to development in ways that significantly alter the natural environment, including:

- Clearing for horticulture and pastoral purposes has affected most of the land to the south, east and north of the site.

- The establishment of extensive pine plantations within State Forest 65 has resulted in the removal of large tracts of native vegetation and changes to the underlying groundwater.

- Horticultural landuse to the north and south of the site, and urbanisation at Joondalup to the south west, has extensively removed natural vegetation.

- Groundwater abstraction by the WAWA and by market gardeners, together with clearing and silviculture, have modified the groundwater regime. The nett effect of these activities is that the regional water table now appears to be lower than in previous years. Figure 7 shows long term groundwater levels as recorded by a WAWA monitor bore located at Lake Adams.

- Land at Carramar Heights to the north west has been developed for Special Rural purposes and a turf farm.

- A proposed golf course within POS at Carramar Heights.

- The Wanneroo Golf Course has been established to the north of the site.

- An industrial zone is under development to the immediate north of the site.

Although the northern portion of the site remains in apparent good biological condition, the site is located in an environment that has been significantly altered.

3.2.2 Vegetation and Flora

3.2.2.1 Regional Perspective

The site is located in a region for which vegetation has been classified in a general scheme by Beard (1979) as part of the Spearwood Vegetation System. The principal component of the vegetation is *Eucalyptus* woodland with transition to the north of Wanneroo into *Banksia* low woodland in which Eucalypts are gradually isolated into smaller and more open stands.

The Spearwood Vegetation System is described in overall terms as a Tuart (*Eucalyptus gomphocephala*)-Jarrah (*Eucalyptus marginata*) woodland association. The distribution of the various component vegetation types is primarily a function of surface soil type, depth and moisture regime. Tuart, Jarrah and *Banksia* are found on deeper, well-drained sands and Flooded Gum (*Eucalyptus rudis)* and Paperbark (*Melaleuca preissiana)* are found associated with wetter soils.

More detailed regional vegetation maps presented in DCE (1980) classify the site's remaining vegetation as Karrakatta Complex - Central and South. This vegetation complex is generally described as predominantly an open forest of Tuart-Jarrah-Marri *(Eucalyptus calophylla)* with a mid-stratum of *Banksia spp.* On the deeper sands of the Karrakatta Central and South Complex, the Tuarts are replaced by Jarrah.

Vegetation within the northern part of the site is typical of Karrakatta Central and South Complex which have developed on deeper sands. The upper stratum is dominated by *Eucalyptus marginata* whilst the mid-level stratum consists of a variable mixture of *Banksia menziesii, B. attenuata* and *B. ilicifolia.* The understorey is generally species rich and is locally variable in height, density and species composition according to the depth of soil, moisture content, aspect and upper storey canopy coverage.

3.2.2.2 Local Perspective

Site surveys were conducted to examine the variations in structure and floristic composition that occur throughout the site and to assess the vegetation's present condition. The results of survey are shown on Figure 8 and are described below.

1. Uncleared Northern Portion

Three generalised vegetation types occur within the uncleared northern portion (Figure 8) of the site. These are Jarrah-*Banksia* woodland, *Banksia* woodland and *Melaleuca* dampland. Jarrah-*Banksia* woodland and *Banksia* woodland occur through most of this uncleared component and there is a small area of *Melaleuca* dampland adjacent to Pinjar Road in the south-eastern corner of the site. The Jarrah-*Banksia* and *Banksia* woodlands occur in a mosaic pattern, with gradients in physical stature and species composition occurring between recognisable areas of each type. The pattern of distribution makes mapping of the individual vegetation types of questionable value. However where compositions are discrete and recognisable, the site's vegetation types may be described as follows:

(a) *Banksia* Woodland

Dominant Species: *Banksia attenuata* and *Banksia menziesii*

Associated Species: *Eucalyptus marginata, Eucalyptus todtiana, Allocasuarina fraseriana, Gastrolobium ilicifolium, Xanthorrhoea preisii, Adenanthos cygnorum, Lysinema ciliatum, Leucopogon pulchella, Hibbertia hypericoides, Calothamnus sanguineus, Hypocalymma robustum, Acacia pulchella, Stirlingia latifolia, Allocasuarina humilis, Conospermum stoechadis.*

(b) Jarrah-*Banksia* Woodland

Dominant Species: *Eucalyptus marginata, Banksia attenuata, Banksia menziesii.*

Associated Species: *Allocasuarina fraseriana, Acacia saligna, Acacia pulchella, Acacia xanthina, Hibbertia hypericoides, Hypocalymma robustum, Jacksonia sternbergiana, Xanthorrhoea preisii, Banksia ilicifolia.*

(c) *Melaleuca* Dampland

Dominant Species: *Melaleuca preissiana, Eucalyptus rudis, Banksia ilicifolia.*
Associated Species: *Patersonia occidentalis, Macrozamia reidlei* and sedges.

The vegetation within the northern section of the site, particularly within the central region, is predominantly in good condition. However, there is a network of sand tracks which traverse

the site and lead to areas where woodcutting or illegal rubbish dumping has occurred. Degraded vegetation is mainly restricted to near the perimeter of the block, adjacent to the local sealed roads. The vegetation does not appear to have been burnt in the recent past.

A series of site traverses were carried out on foot to indicate whether dieback is present within the site. This investigative work focussed on a search for affected individuals of indicator species, including *Banksia grandis* and *Macrozamia riedlei*, in susceptible areas such as along the edges of tracks and trails. No obvious signs of dieback infection were recorded. It is acknowledged that this visual methodology is not entirely definitive, however it is nonetheless indicative of the status of the site.

2. Southern Portion

The southern part of the site has been almost completely cleared for grazing, and there are only three relatively small areas of vegetation remaining (Figure 8). Two of these areas are distinguishable as the *Banksia* woodland vegetation type described in (1) above, although previous landuse has significantly altered their floristic character. The third area of remnant vegetation, located on low-lying land in the south east corner of the site (on the north west corner of the Pinjar Road - Clarkson Road intersection), is lower slope vegetation associated with the small wetland that occurs in the south-west quadrant of the Clarkson Road - Pinjar Road intersection. This remnant stand is classified as *Melaleuca* dampland vegetation type and exhibits the same dominant species as described in (1c) above. The associated species include:

Regelia ciliata, Hypocalymma angustifolium, Scholtzia involucrata, Astartea fascicularis, Burtonia scabra, Platytheca galioides, and *Patersonia occidentalis.*

The remaining parts of the southern section of the site have been variably replanted with *Eucalyptus* species and now have an open parkland configuration of replanted trees, regrowth thickets and individual specimens of the former vegetation. A profusion of pasture grasses and exotic weeds have become established and "bare" ground occurs where limestone is shallow or outcrops.

The remnant patches of native vegetation within the southern section are generally in very poor condition, having been grazed and significantly trampled by stock. Understorey regrowth has occurred within the *Banksia* woodland remnants, however these areas appear to have much lower floristic diversity than corresponding areas in the northern portion of the site, and are significantly affected by weed invasion.

The *Melaleuca* dampland remnant is also in poor condition due to stock damage and also appears to have been frequently burnt.

3.2.2.3 Rare and Restricted Flora

The site's flora was investigated with specific regard to gazetted rare, geographically restricted or poorly collected species. These investigations involved the following:

(i) Review of the floristic data base for gazetted rare species developed by CALM's Metropolitan Branch. No records of known occurrences of gazetted rare species within the site were found.

(ii) The potential for the occurrence of gazetted rare species was assessed from a regional appraisal conducted for the Gnangara Mound area by the Water Authority of Western Australia (1986). This work identified 13 species of vascular plant for the Gnangara Mound that were gazetted rare, geographically restricted or poorly collected. Habitat and geographical distribution data for these species was assessed in terms of the potential for populations to exist within the site. The results are as follows:

- Seven of the species have been recorded in wetland habitat. These are:
  - *Conospermum huegelii*
  - *Darwinia* sp. A. (D. aff. *neildiana*)
  - *Eremaea purpurea*
  - *Lycopodium serpentinum*
  - *Restio stenostachya*
  - *Stylidium utricularioides*
  - *Thelymitra* sp. A. (Th. aff. *carnea*)

- Searches for these species within the sites very limited areas of dampland were conducted during August 1989. No populations were located. There is a small possibility that a hybrid orchid of interest (*Thelymitra* sp.) could occur in the dampland areas, however recent lowering of the water table (see Figure 7) may now preclude its existence in this locality.

- Four of the thirteen species have been recorded from *Banksia* woodland, and two from open woodland or scrub vegetation. These species are as follows:

- *Conostephium minus*
- *Lysinema elegans*
- *Stachysteman axillaris*
- *Tetratheca pilifera*
- *Cartonema philydroides*
- *Lhotskya brevifolia*

Based on the recorded soil type preferences and distributions of these species, it is unlikely that *Lhotskya brevifolia* or *Lysinema elegans* would occur within the Spearwood Sand soils of this site. There is a small possibility that *Cartonema philydroides*, *Conostephium minus*, *S. axillaris* or *T. pilifera* may occur on the site, however these species were not observed during the flora survey work carried out during August 1989.

3.2.3 Fauna

The Western Australian Museum (WAM) conducted an extensive regional survey of vertebrates of the Northern Swan Coastal Plain in 1978. This survey is the most comprehensive of it's kind ever carried out for the area, and included 315 man-days and 25,729 trap nights.

The areas chosen for study sampled the major geomorphic elements and representatives of the majority of vegetation formations recorded on the Plain. Reserves were preferentially chosen for sampling within the study area as they were generally large, relatively undisturbed and consequently most likely to contain fauna.

The terrestrial areas surveyed included, from north to south:

- Moore River National Park
- Gingin Proposed Reserve
- Melaleuca Park
- Twin Swamps Reserve
- Yanchep National Park, and
- Neerabup National Park/Burns Beach.

The intensive effort incorporated into the WAM survey could not be exceeded (or equalled) for the current study. Therefore, a limited fauna survey of the site, including traverses throughout the significant habitat types, was conducted to observe fauna species and to

identify and evaluate available habitats. The information gathered was subsequently correlated to results of the WAM survey, to indicate the fauna species likely to occur given the prevailing habitat types available. Although the present site was not specifically incorporated into the Museum's study, *Banksia* woodland habitat typical of the site was closely examined. Spatially, the Neerabup National Park (Reserve No. A27575), vested in the National Parks and Nature Conservation Authority, is very close to the site, and additionally contains several of the formations common on the Spearwood Dune System (WAM, 1978). During the WAM survey, trap lines were set adjacent to the site on the Reserve immediately north of Burns Beach Road. Trapping effort for this Reserve was 5008 trapnights, using Elliot, breakback, cage and pit traps.

While the vegetation complexes contained within the Park are not identical to those within the subject site they are very similar, and Neerabup National Park contains a larger extent of wet or dampland areas. Nonetheless, the resultant database is indicative of the range of vertebrates which may inhabit similar habitats within the site.

3.2.3.1 Mammals

A literature review and search of Western Australian Museum records by Kitchener *et al.* (1978) concerning the presence of native mammal species on the Northern Swan Coastal Plain concluded that 33 species had previously been recorded with certainty, and an additional four species had been recorded but were of doubtful origin. Six introduced mammal species were also recorded. During the 1978 WAM survey however, only 12 native mammal species were recorded, with 6 introduced species.

Table 2 lists the mammal species recorded from the Northern Swan Coastal Plain from historical records, museum records, and the WAM survey. The majority of species inhabit heath, shrubland or woodland habitats. Some species, such as the Southern Brown Bandicoot and Water Rat require or prefer habitat containing areas of open water.

Neerabup National Park, adjacent to the subject site, recorded two species of native mammal, the Western Grey Kangaroo (*Macropus fuliginosus*) and the Western Brush or Black-Glove Wallaby (*M. irma*). The kangaroo *M. fuliginosus* was the only mammal confirmed on-site during the present study.

The presence of the Black-Glove Wallaby adjacent to the study site by the WAM survey is significant, as the Department of Conservation and Land Management consider it may be a declining species. It is not, however, a gazetted rare or endangered animal.

Table 2

Mammal Species Recorded from the Northern Swan Coastal Plain

MAMMAL SPECIES	COMMON NAME	PREVIOUSLY RECORDED	KNOWN NSCP	1978 WAM Survey	NEERABUP N.P.	RECORDED ON-SITE
MACROPODIDAE						
Macropus fuliginosus	Western Grey Kangaroo	•	1972	•	•	•
Macropus irma	Western Brush Wallaby	•	1974	•	•	
Macropus eugenii	Tammar Wallaby	•				
Petrogale lateralis	Brush-tailed Rock Wallaby	?				
Onychogalea lunata	Wurrung	•				
Bettongia penicillata	Woylie	•				
Bettongia lesueur	Boodie	•				
Setonix brachyurus	Quokka	•				
Lagostrophus fasciatus	Munning	?				
PHALANGERIDAE						
Trichosurus vulpecula	Common Brushtail Possum	•	1907	?		
Pseudocheirus peregrinus	Common Ringtail Possum	•				
BURRAMYIDAE						
Cercartetus concinnus	Western Pygmy-possum	•	1930			
TARSIPEDIDAE						
Tarsipes rostratus	Honey-possum	•	1988	•		
PERAMELIDAE						
Isoodon obesulus	Southern Brown Bandicoot	•	1977	•		
THYLACOMYIDAE						
Macrotis lagotis	Dalgyte	•				
DASYURIDAE						
Dasyurus geoffroii	Western Quoll	•	1972			
Antechinus apicalis	Dibbler	•				
Antechinus flavipes	Yellow-footed Antechinus	•				
Phascogale tapoatfa	Tuan	•				
Sminthopsis crassicaudata	Fat-tailed Dunnart	•	1929			
Sminthopsis griseoventer	Common Dunnart	•				
Sminthopsis granulipes	White-tailed Dunnart	•				
MYRMECOBIIDAE						
Myrmecobius fasciatus	Numbat	•				
MURIDAE						
Rattus fuscipes	Brush Rat	•	1975	•		
Rattus tunneyi	Tunney's Rat	•				
** Rattus rattus*	Common Rat	•		•		
Hydromys chrysogaster	Water Rat	•	1914	•		
Pseudomys albocinereus	Ash-grey Mouse	•		•		
** Mus musculus*	House Mouse	•	1975	•	•	
MEGADERMATIDAE						
Macroderma gigas	Ghost Bat	?				
VESPERTILIONIDAE						
Nyctophilus geoffroyi	Lesser Long-eared Bat	•		•		
Eptesicus regulus	Southern Little Bat	•		•		
Chalinolobus gouldii	Gould's Wattled Bat	•	1978	•		
Chalinolobus morio	Chocolate Wattled Bat	•	1924			
Myotis adversus	Large-footed Myotis	•				
MOLOSSIDAE						
Tadarida australis	White-striped Mastiff-bat	•				
Mormopterus planiceps	Little Mastiff-bat	•				
PTEROPODIDAE						
Pteropus scapulatus	Red Flying Fox	?				
CANIDAE						
Canis familiaris	Dingo	•	1966			
** Vulpes vulpes*	Fox	•	1959	•	•	
MUSTELIDAE						
**Mustela putorius*	Ferret	•		•		
FELIDAE						
** Felis catus*	Feral Cat	•		•	•	
LEPORIDAE						
** Oryctolagus cuniculus*	Rabbit	•		•	•	
TACHYGLOSSIDAE						
Tachyglossus aculeatus	Echidna	•	1985	•		

* Introduced species.
Previously Recorded - on Northern Swan Coastal Plain (NSCP) by historic records. ? - doubt exists as to identification or occurrence.
Known NSCP- Year recorded from the Wanneroo area as per WA Museum (WAM) mammal database (latest year recorded).
1978 WAM Survey - Recorded during 1978 WAM Northern Swan Coastal Plain Survey.
Neerabup NP - Recorded from Neerabup National Park adjacent to site in 1978 WAM survey.
Recorded On-Site - Recorded during on-site surveys.

Kitchener *et al.* (1978) report that *M. irma* was frequently sighted during the 1977/78 survey: 14 in Neerabup National Park; 26 in the Mullaloo/Burns Beach area; 4 in Melaleuca Park; 3 in Yanchep National Park; 6 in Gin Gin; and 4 at Moore River. However, this species was not common in the open by day, but was most frequently observed at night in mixed *Banksia menziesii* woodlands, both burnt and unburnt.

From a conservation perspective, it is important that the presence of this species has been confirmed by scientific survey in the National Parks and Reserves in the locality, where both habitat and fauna will be preserved.

Discussions with the Department of Conservation and Land Management's Metropolitan Regional Office, to determine whether any gazetted rare fauna species are known to inhabit the site, indicated that the gazetted rare Chuditch (Western Quoll or Native Cat) *Dasyurus geoffroii* is thought to occur within the locality but has not been specifically recorded on site. The 1978 WAM survey did not record the Native Cat from the areas surveyed, and the animal was last recorded from the Northern Swan Coastal Plain in 1972.

3.2.3.2 Reptiles and Amphibians

Storr *et al.* (1978a) undertook a comprehensive survey of the herpetofauna (reptiles and amphibians) of the Northern Swan Coastal Plain as part of the overall WAM survey of 1977/78. The Plain was divided longitudinally into three zones, corresponding approximately to the Spearwood (western zone), Bassendean (central zone) and Guildford (eastern zone) Formations.

The western zone of the study area, which includes the site, contained 57 species of herpetofauna. Table 3 shows the general distribution of herpetofauna families in the western zone of the study area, compiled by Storr *et al.* (1978a).

In general, the survey indicated that the western zone supported a greater diversity of Gekkonidae (geckos) than the other zones (2 and 3 species respectively for the central and eastern zones), primarily due to the greater presence of limestone outcrops in the more coastal western zone.

In order to indicate the herpetofauna likely to inhabit or traverse the subject site, data recorded in the WAM survey was analysed for specific locality distribution either at adjacent Neerabup

Table 3

Herpetofauna Families of the Western Zone of the Northern Swan Coastal Plain

Family	Common Name	No. Species
Leptodactylidae	Ground Frogs	5
Hylidae	Tree Frogs	2
Cheluidae	Side-Necked Turtles	1
Gekkonidae	Geckos	6
Pygopodidae	Legless Lizards	7
Agamidae	Dragon Lizards	2
Scincidae	Skink Lizards	18
Varanidae	Monitor Lizards	2
Typhlopidae	Blind Snakes	1
Boidae	Pythons	2
Elapidae	Front-Fanged Snakes	11

National Park for reasons previously discussed, or in the Wanneroo area in general. Table 4 presents the species of herpetofauna of the National Park and the northern Wanneroo districts.

It is acknowledged that this list is indicative only, and that a greater or lesser number of species may be found on or in the vicinity of the site. However, once again the trapping effort involved with the WAM survey resulted in a comprehensive data base for the area, one that could not have been replicated for the current study.

Only one species recorded from any family is included in the current (gazetted 1990) list of gazetted rare or endangered wildlife. This animal, the Western Swamp Tortoise *(Pseudemydura umbrina)*, is confined to the seasonal swamps along Ellen Brook, and is therefore not present in the vicinity of the site, and will not therefore be impacted by the proposal.

Table 4

Herpetofauna of Neerabup National Park and the Wanneroo Area

Family	Species
Leptodactylidae	*Heleioporus eyrei* *Limnodynastes dorsalis* *Myobatrachus gouldii (W)* *Pseudophryne guentheri* *Ranidella glauerti*
Hylidae	*Litoria adelaidensis* *Litoria moorei (W)*
Gekkonidae	*Crenadactylus ocellatus ocellatus* *Diplodactylus polyophthalmus* *Phyllodactyllus marmoratus* *Phyllurus millii (W)*
Pygopodidae	*Apraisia repens* *Lialis burtonis (W)*
Agamidae	*Amphibolurus minor minor*
Scincidae	*Cryptoblepharus plagiocephalus* *Ctenotus impar (W)* *Egernia napoleonis* *Hemiergis peronii quadrilineata* *Lerista praepedita* *Menetia greyii* *Omolepida branchialis (W)* *Tiliqua rugosa rugosa*
Varanidae	*Varanus gouldii* *Varanus tristis tristis* *Typhlina australis (W)*
Elapidae	*Brachyaspis curta (W)* *Denisonia coronata (W)* *Denisonia gouldii* *Notechis scutatus occidentalis (W)* *Pseudonaja affinis affinis* *Vermicella bertholdi* *Vermicella bimaculata* *Vermicella calonotos (W)* *Vermicella semifasciata semifasciata*

Note: Unless designated (W) for general Wanneroo distribution, species were recorded from Neerabup National Park.

3.2.3.3 Birds

The bird fauna of the Northern Swan Coastal Plain have been documented by Storr *et al.* (1978b) as part of the WAM survey of 1977/78. A total of 223 bird species were recorded, with information regarding distribution, relative abundance, faunal status, habitat preference and breeding season.

It is not proposed to systematically list the species recorded from the study, as the majority of species are relatively mobile, and for many the description of distribution is on an opportunistic basis.

In general, the clearing of the coastal vegetation, especially forests and that surrounding wetland areas, has reduced the number of bird species found in the metropolitan region. Other significant factors contributing to the decline in species numbers include the introduction of exotics, population explosions of competitive species, the use of pesticides, and natural variation.

Other native species of birds have benefited from the clearing and farming or urbanisation, however Storr *et al.* (1978b) consider that the birds of the *Banksia* dominated sand plains have been least affected by European man.

3.2.4 Local Wetlands

A series of wetlands are located to the east of the site which form part of the Wanneroo Wetlands - Eastern Chain. Of this series, Lake Adams is the closest large wetland to the site, located approximately 500m to the east of the eastern site boundary. Other eastern wetlands include, from the north, Little Coogee Swamp, Little Mariginiup Lake, Mariginiup Lake, Jandabup Lake and a series of unnamed swamps and winter wet depressions. These areas are included in System Six Recommendation M8 (DCE,1983).

Most of the wetlands within the M8 recommendation area have been significantly modified by agricultural and other land uses. For example, the seasonally wet low-lying land around Lake Adams has been fully cleared for livestock grazing and drier land located at its western margins has been developed as a Special Rural estate. The wetland itself has been significantly effected by water table lowering caused by a combination of silvicultural landuse within State Forest 65, groundwater abstraction by the Water Authority and the local horticultural industry. Figure 7

shows a monitor bore hydrograph that depicts groundwater levels in the vicinity of Lake Adams for the period 1964 to an estimated level in 1990.

In its natural state Lake Adams was a "mature" wetland approaching the final stage in its progression, being broad, shallow and covered in virtual entirety by reed beds. Prior to local development the lake bed probably became quite dry when the water table level dropped to its seasonal minimum height during autumn.

Water table lowering due to local land uses, including pine plantations for timber production (WAWA, 1986), has exacerbated the natural seasonal drying cycle such that the owners of the Lake Adams land have dredged a part of the lake basin adjacent to the Special Rural estate, to provide an area of permanent surface water. An earth-bank causeway has been constructed around the open water area using fill from the excavated area, and has been vested in the local authority as a Nature Reserve.

Lake Joondalup is a major wetland to the west of the site and is the subject of System Six Recommendation M7 which recommends its incorporation within a Regional Park. This recommendation is now being implemented through Yellagonga Regional Park Planning Study (DPUD, 1991b). Lake Joondalup is generally in good biological condition and has high conservation value, but presently exhibits enriched nutrient status.

A smaller permanent wetland is located within privately owned land directly west of the site on the western side of Wanneroo Road. This wetland appears to be in good biological condition and has been recommended for incorporation within Neerabup National Park (DCE, 1983).

Despite the changes that have occurred to local wetlands as a result of surrounding land use practice, in general they continue to support valuable vegetation, flora and fauna and in some areas provide important drought refuge, and on this basis have high conservation value.

3.3 Social Environment

3.3.1 Land Zoning and Ownership

Both the project site and the majority of surrounding land is zoned for rural purposes under both the Metropolitan Region Scheme (MRS) and the City of Wanneroo Town Planning Scheme No. 1 (WTPS No. 1). Subdivisions located in the vicinity of the project site have Special Rural

zoning under the WTPS No. 1 (Figure 9). Most of the land in the vicinity of the project site is in private ownership, the exceptions being land within State Forest 65 which is Crown land vested in the Department of Conservation and Land Management (CALM), the Wanneroo Golf Course and Neerabup National Park.

The project site will need to be rezoned from Rural to Urban under the MRS and from Rural to Residential Development under the WTPS No. 1 for the present development proposal to proceed.

3.3.2 Land Use

3.3.2.1 Current Land Use

Current land use of the site is as follows:

- Approximately 40% of Lot 1 Flynn Drive has been cleared and is currently used for floriculture. The balance of this lot remains as native vegetation.

- Lot 2 remains fully vegetated. The sandy tracks that traverse the site are used by local horse riders and there is evidence of woodcutting in certain locations. Illegal rubbish dumping is also evident.

- The majority of Location 2579 has been cleared for grazing. Three remnant stands of Banksia woodland remain and regrowth of native species has occurred in parts of the cleared areas. The owner has previously selectively replanted sections of the cleared area in an open parkland format, mainly with Eucalypts.

Land uses surrounding the site are predominantly rural (Figure 9). The following land use types may be distinguished:

To the North;

- Industrial land
- Horticulture
- Motor Racing Circuits
- State Forest 65 (Pine Plantations)
- Limestone Quarries

- Wanneroo Golf Course
- Uncleared land zoned Rural

To the West;

- Selectively cleared Special Rural development (Carramar Heights)
- Horticulture
- Major roads (Wanneroo Road, Burns Beach Road)
- System Six Recommendation areas (Lake Joondalup, Neerabup National Park)
- Proposed Yellagonga Regional Park (Lake Joondalup, Lake Goolellal, Walluburnup and Beenyup Swamps)
- Joondalup Development Area and Centre
- Neerabup National Park

To the South;

- Horticulture
- Poultry Farms
- Low density (rural zoning) residential development
- Silviculture
- Equestrian uses

To the East;

- Stock agistment
- Horticulture
- Special Rural land
- Groundwater abstraction bores (Wanneroo Scheme)
- System Six Recommendation areas (Lake Adams, Mariginiup and Little Mariginiup Lake)
- Equestrian uses
- Silviculture (State Forest 65)
- Vineyards

3.3.2.2 Yellagonga Regional Park

The Yellagonga Regional Park concept was developed to provide for the protection of open space of regional significance for conservation, landscape protection and recreation.

The Yellagonga Regional Park will incorporate approximately 1500ha of land recommended for protection under System Six Recommendation M7, including Lake Joondalup, Lake Goollelal, Walluburnup and Beenyup Swamps. Reservation of the extensive wetland system will provide habitat requirements for a range of waterbirds and allow for protection of the fringing woodland vegetation along with sites of cultural significance. Recreational features including dual use paths and picnic areas will be established to cater for a range of users.

3.3.3 Landscape

The existing landscape and associated visual characteristics within the site and surrounding areas are described in Appendix B and summarised herein.

The landscape to the west of the site consists of dune and swale landforms in parallel sequence, featuring sand and limestone ridge formations, extensive linear wetlands and woodland. To the east of the site, the land is more gently undulating and includes large circular wetlands and associated seasonally wet flats, together with areas of *Banksia* woodland.

The natural landscape has been substantially modified by land use development. The site is located near the northern periphery of intensive urban development in the Wanneroo area, and the urban landscape is well established to the south. There is a gradation to semi-rural and rural landscapes to the north.

The site itself presents two principal landscape elements:

1. The southern area appears as derelict farmland with *Eucalyptus* trees and limited areas of natural regrowth. There are extensive areas of bare or minimally vegetated ground, although this harsh appearance is softened by grass and weed growth during winter.

2. The northern area of the site presents a landscape of natural woodland.

The site is visible from approximately 7.5km of existing roads, namely Wanneroo Road, Pinjar Road and Clarkson Avenue. The view of the site from these roads varies in distance and aesthetic value, but includes sections of natural woodland.

Views available from the site are also variable. The central ridge in the northern part of the site allows significant views, particularly to the southwest.

The most significant viewscapes in the area are considered to be those across the linear wetlands and towards the dune ridge formations to the west of Wanneroo Road.

3.3.4 Groundwater Management Policy Areas

The site is located in the Carramar sub-area of the Wanneroo Groundwater Area, which was proclaimed under the Water Authority Act, 1984 and is managed by the Water Authority of WA. The Water Authority has developed a Management Plan for the groundwater resource and regulates groundwater abstraction through compulsory licensing, to prevent over-utilisation.

Figure 10 shows the location of the Wanneroo Groundwater Area and other groundwater management areas within the region. This part of the Metropolitan Region, particularly the land to the north-east of the present site, overlies an extensive shallow groundwater resource that is important for both environmental and public water supply purposes. Ongoing management of this resource, to protect its quality and quantity, is therefore a priority. The implementation of management policies has been facilitated by proclamation of management areas as summarised below:

- The Gnangara Water Reserve is located to the north-east of the site. The Metropolitan Water Supply, Sewerage and Drainage Act, 1909 (MWSSDA), enables the Water Authority to develop and regulate water resources within this area.

- The Wanneroo Underground Water Pollution Control Area (UWPCA) and Public Water Supply Area (PWSA) is located to the immediate east of the site. By-laws proclaimed under the MWSSDA, empower the WAWA to control land use that has the potential to cause groundwater pollution in this area.

- The Perth Coastal UWPCA is located to the immediate west of the site. Land use in this area is regulated to prevent groundwater pollution.

- The Gnangara Mound Groundwater (Crown Land) Environmental Protection Policy, presently in draft form for public review, will apply to land located to the immediate north-east of the site. The purpose of this policy will be to protect the quality and quantity of the groundwater resource for identified uses including:

    - Public Water Supply - for the abstraction of groundwater by the Water Authority for public water supply purposes.

- Ecosystem Maintenance - for the maintenance and preservation of terrestrial and aquatic ecosystems that are dependent on groundwater.

3.3.5 Noise

Possible noise impact upon the development due to the site's proximity to motor racing venues was investigated to enable assessment of this concern. The results of this investigation are described in Appendix C and are summarised in the following.

There are four motor racing venues near the development site, as follows:

- The Wanneroo Park Motor Racing Circuit, located 2km north of the site.
- The Wanneroo Park Motorcycle Racing Circuit, located adjacent to the Motor Racing Circuit and also approximately 2km from the site;
- The International Standard Go-Kart Racing Circuit, located east of the Motorcycle Racing Circuit and also approximately 2km from the site;
- The Wanneroo Motocross Track, located approximately 750m north of the site.

Table 5 describes the frequency of racing and practice events at the four racing venues.

Table 5

Frequency of Racing and Practice Events at the Wanneroo Racing Sport Venues

Venue	Racing	Practice
Motor Racing Circuit	8 weekend events per year	3 days preceding each event
Motorcycle Racing Circuit	6 weekend events per year	3 days preceding each event
Go-Kart Racing Circuit	12 weekend events per year	Daily, including hire kart facility
Motocross Track	14 weekend events per year	Informal.

Noise surveys were conducted by specialist consultants on six occasions, including surveys during events at the above venues.

Background noise levels throughout the site were measured within the range 27-55 A-weighted decibels (dB(A)), however most levels were between 27-45dB(A). Songbirds and wind rustling trees were predominantly responsible for readings in the upper range, with chirping being recorded at 55 dB(A). Nearby traffic and local agricultural machinery also contributed to background noise. Higher noise levels were typically recorded near to Wanneroo and Pinjar Roads, particularly in the southern parts of the site where vegetation has been largely cleared. Noise levels (L_{10} 18 hr)[2] of 35-50 dB(A) are typical of residential background noise, whilst 45-60 dB(A) levels are common adjacent to roads, with the higher values corresponding to periods of peak traffic movement (D. Nunn, EPA, pers. comm.). Background noise levels at the site are therefore at present comparable to those generated in a typical urban environment, and would not be expected to change significantly following development.

Noise measurements during the 1989 National Sports Sedan Challenge at Wanneroo Park Motor Racing Circuit showed that noise from this source is most audible in the north of the site, where levels were 5-10dB(A) above the ambient levels, with Lmax (the maximum noise recorded) recorded at 50 dB(A). The additional noise levels reduce considerably with increasing distance to the south, due to both distance from the source and to shielding by the ridge of high ground located within the central part of the site.

A noise survey during simultaneous events at the Wanneroo Motorcycle Racing Circuit and the Wanneroo Motocross Track showed that in combination, these episodic sources cause a 10-15dB(A) increase in noise levels within the northern part of the site, reducing to a faintly audible or inaudible noise within the southern parts of the site. The maximum noise recorded on the site during this event was 56 dB(A).

3.3.6 Aboriginal Heritage

An ethnographic and archaeological survey was conducted within the site by McDonald Hale and Associates. The results of the survey are summarised below and a Summary Report in compliance with the Aboriginal Heritage Act, is provided as Appendix D.

[2] L10 18 hr - the noise level which 10% of noise measures exceeded, over an 18 hour period)

3.3.6.1 Archaeology

Aboriginal archaeological sites are those at which material artefacts are found. A review of the register of known archaeological sites held at the Western Australian Museum's Department of Aboriginal Sites showed that no sites are known within the survey area. Within a radius of 5km of the proposed development area, 8 sites of archaeological significance have previously been recorded, mainly associated with the wetlands.

An intensive site investigation was carried out and no trace of any Aboriginal sites or evidence of Aboriginal occupation was found within the survey area.

3.3.6.2 Ethnography

Ethnographic sites are those areas which are racially significant from a historical or mythological perspective. A search of archive material held at the Department of Aboriginal Sites revealed that there were no recorded ethnographic sites in the survey area.

A site visit in the company of an Aboriginal spokesperson recognised as knowledgeable of traditional sites in the Wanneroo area revealed an ethnographic site of mythological significance in a small seasonally damp area in the north-east corner of the site adjacent to Pinjar Road (opposite the junction of Lee Steere Drive). This site is associated with the presence of the mythological honey possum, and is located within a proposed Public Open Space area of approximately 4 ha. Consultation with the spokesperson was unable to record the relevant stories related to the site during the interview.

The identification of the mythological site has been formally registered with the Department of Aboriginal Sites.

3.3.7 European Heritage

There are no sites of European cultural or historic significance listed for the site. However eight sites occur within a 1km radius of the site's boundary (City of Wanneroo, 1988). Of these, six are houses and the remaining two are a scarp working (quarry) and a lime kiln. Figure 11 shows the location of these sites.

4.0 PROJECT DESCRIPTION

This development proposal is for a "Development Plan" for urban development of the site generally as shown on Figure 12 (Development Concept). The scope of the "Development Plan" is to define the location of major landuses and services facilities for the site. Detailed subdivision plans will be prepared following Government approval of the "Development Plan". However, the broad planning for the proposed development, including the design philosophies that will be observed in formulating the subdivision layout and the environmental planning considerations, are identified and summarised in this section to provide background for assessment.

4.1 Project Components

4.1.1 Urban Residential Densities

It is intended that the project area will be developed with a variety of residential lot sizes and densities, with the overall project having a density commensurate with the policy guidelines of the DPUD, including a more efficient use of new urban land to reduce the costs of housing, especially for first home buyers, such as provision for smaller residential lots and narrower residential road reserves.

Overall residential densities will generally accord with the intent of the R15 and R17.5 Residential Codes, that is, with nett residential densities in the order of 12.5-15 lots/hectare. There will be selected pockets of higher density development in appropriate locations close to public open space, retail and community centres and public transport links. There will also be areas of lower density housing of 10-12.5 lots/ha.

It is anticipated that the overall project will yield in the order of approximately 8,000 to 9,000 dwellings, which can be expected to accommodate a population in the order of 24,000 to 28,000 at the completion of development.

4.1.2 Neighbourhood Cells

It is intended that the project will be developed as a series of residential neighbourhood cells, focusing on areas of public open space where practicable, as indicated on the Development Plan (see Figure 12). The cells will relate to the commercial and community infrastructure elements to be developed and will be served by systems of culs-de-sac, ensuring minimal through traffic and maximum social interaction within the resident communities. All access roads, access-ways and access places will have less than 3,000 vehicles per day (v.p.d.) and consequently will be available for direct residential access. Those roads which are anticipated to have in excess of 3,000 v.p.d. will be subject to innovative traffic management techniques, in accordance with practices acceptable to DPUD and the City of Wanneroo.

The road system will be designed in accordance with the policy guidelines of the DPUD and to the satisfaction of the City of Wanneroo. Where appropriate, integral dual-use pedestrian and cycle paths will be developed within each residential neighbourhood cell.

The range of lot sizes that will be provided will recognise the flexibility currently demanded in new urban subdivisions, as a result of changing household characteristics. The 'traditional' family of two parents with children represents only about 40% of total metropolitan accommodation demand, although this percentage is likely to be considerably higher in this project. The need to cater for other household structures is recognised in the project, particularly within the Homeswest area where it is intended to provide a multiplicity of accommodation types to cater for the needs of a wide section of the community.

The traditional single family allotment will be dominant within the western area, subject to the policy of the State Government and the DPUD for increased urban densities and the desire of the developer to provide some variety of choice in lot sizes and other market directed characteristics. Homeswest and the R&I Bank intend to develop their land holdings to a density equivalent to Residential Code R17.5, whereas Yatala Nominees will be developing to the slightly lower overall density - R15, now advocated by the DPUD.

The estate will be designed around large cells generally of 200-400 lots each, with the flexibility outlined above being an integral part of each of the cells. It is also recognised that the estate will need to be able to adapt to changing lifestyles and family characteristics over time, reinforcing the need for some flexibility in design.

4.1.3 School Sites

The number of resident families within the project will be likely to have a higher than average school age population complement and provision is made within the Development Plan for a total of six primary school sites (five of four hectares each, and one of six hectares), and one high school of ten hectares.

The schools are located in optimal locations, generally at the centre of their catchments. All primary schools will have areas of public open space adjoining the school and will be served by appropriate pedestrian and cycleway systems.

The precise location and shape of each school site will be subject to negotiation and agreement with the Ministry of Education in the course of the subsequent detailed subdivision design phase. Detailed design and abutting road patterns will accord with the policy guidelines of the Department of Planning and Urban Development and requirements of the Minister of Education.

4.1.4 Commercial and Community Centres

The draft policy of the DPUD outlined in the "Perth Metropolitan Region - Commercial Centres Policy" published by the State Planning Commission in March, 1989, establishes new floorspace per capita standards of $0.5m^2$ and $0.52m^2$ respectively for District and for Neighbourhood Centres. The standards indicate that the population retail expenditure will support a District Centre of $13,500m^2$ Gross Leasable Area (G.L.A.). A total of approximately $12,200m^2$ GLA will be provided within the five Neighbourhood Centres, in accordance with a detailed Commercial Centres Analysis carried out by Shrapnel Urban Planning (1992).

The Development Plan has been designed in accordance with the new draft policy and establishes a central site of approximately 16.2 hectares for a proposed District Centre located centrally within the project, at the major intersection of EW-7 and the north-south local road. The Development Plan provides for five Neighbourhood Centre sites, each of 2.0 to 2.5 hectares, able to accommodate up to $3,500m^2$ GLA.

The District Centre will be a major complex that will service the immediate local and surrounding residential populations, and will establish a commercial and community focus by providing an appropriate mix of services. Approximately 10 hectares of the proposed centre will be used for

a retail centre, which will include the typical range of supermarket and homewares outlets and incorporate ancillary facilities such as retail fuel outlets and tavern. A range of community recreation facilities will be planned for the remainder of the site which will accommodate, for example, a movie theatre complex and associated activities.

Abutting the District Centre will be an extensive area of open space (13.5 ha), designated as District Open Space. The function of this area will include the provision of recreational facilities at a district level. It is centrally located within the project area to ensure maximum exposure and therefore benefit to the community.

The Neighbourhood Centres, which are strategically located to service the residential cells, will provide for Local Authority services which will likely include a library, child minding facilities and the provision for medical centres.

The City of Wanneroo intends to develop a public golf course based upon an expansion of Council owned land within the Carramar Park Special Rural development. To assist the Council in this regard, Yatala Nominees will provide a portion of their POS contribution in the required location, abutting the northern boundary of Loc 2579, as has been agreed with the DPUD.

The balance of the public open space throughout the project area will be provided in locations to best suit the needs of the future community, both as passive recreation spaces and, in some instances, will also act as a buffer adjacent to the major roads. The allocation of POS has been determined in consultation with Council's officers and the DPUD.

4.1.5 Internal Roads

The major internal road system to be developed will incorporate a system that is designed to provide direct and safe access within and throughout the project area, linking the various commercial and cultural elements with the residential neighbourhood cells.

Considerable attention is being directed in the design to ensure that the roads forming the major internal road system have a relatively even distribution of the overall traffic volume and to ensure that they are able to transport vehicles as directly as possible onto the Arterial Road system.

Preliminary traffic analysis indicates that most of the roads forming the internal system are likely to be used by less than 3,000 vehicles per day (vpd), and in consequence will be acceptable as

residential frontage streets. Where traffic volumes will exceed 3,000vpd direct residential frontage access will not generally be developed.

It is intended that some sections of roads for which traffic volumes are expected to be between 3,000-6,000vpd will be developed as "Boulevardes" in conformity with the new road concept, recently adopted by the DPUD and considered acceptable by the City of Wanneroo. Access onto these roads is provided by short lengths of service road which run parallel to the main carriageway and which are located within the same road reserve. These roads are a particular asset where open space abutts one side of the road and a direct view is desired from adjacent allotments.

4.2 Provision of Services

The site offers no real constraints to immediate development other than the need to extend utility services to the area. The costs associated with the provision of services is minimal when the cost is amortised over a landholding of this scale.

4.2.1 Water Supply and Sewerage

The site constitutes a significant part of the land included in the Water Authority's planning for the creation of 24,000 lots in the Quinns/Mindarie/Neerabup priority area during the next four years, required to satisfy the Government's stated policy objective.

The State Cabinet has endorsed a proposal that the Water Authority should provide sufficient sewerage headworks capacity and water supply throughout the priority area, which will be funded by an enhanced headworks contribution payable by the developers within the area.

The provision of these services requires that the development occurs according to a rational and orderly development program and that the necessary service routes are provided within the area.

Discussion with Water Authority officers has determined that, to satisfy the above requirements, several sites are required within the higher Homeswest land holding (Lot 2) for the development of high level water storage tanks and pump stations. Details of the required sites have been provided by the Water Authority and provision has been made for these public utility sites within the Development Concept (Figure 12).

4.2.2 Electricity and Gas Supply

The State Energy Commission of Western Australia (SECWA) proposes to establish a substation on the south western part of Loc 2579 to serve the subject land and additional land areas. The site required is approximately two hectares in area and SECWA advises that the site will be intensively landscaped. A description of the principal elements of the substation has been prepared by SECWA, and is included as Appendix E.

The State Energy Commission's Gas Division advises that the recent extension of the Wanneroo Road main to Burns Beach Road will provide the gas supply necessary to serve the subject land. The general policy of SECWA is to provide reticulation for the gas supply to new residential developments at no cost to the developer. It is therefore concluded that the provision of electricity and gas to the subject land is feasible and readily achievable.

4.2.3 Telecommunications

The site is not considered to be frontal by Telecom Australia as it is beyond the fringe of existing services. As there is not the capacity within the existing network to meet the servicing demand that would be generated by the development of the subject land for residential purposes, Telecom may require a contribution towards the provision of their service. With regard to the proximity of the subject land to the current development front, this cost should be minimal when amortised over the site.

4.2.4 Arterial Road Access

Current planning proposes that the subject land be traversed by a single Arterial Road, namely the eastern extension of Burns Beach Road (EW-7), and will be bounded to the north by another Arterial Road, namely an upgraded Flynn Drive (EW-8).

These roads will serve to link the residential development with Wanneroo Road as well as the other regional arterial road/transportation links, in particular the Mitchell Freeway, the Northern Suburbs Railway to the west, and to the east via Neaves Road to Great Northern Highway.

Following consultation with community groups, the local authority and various government agencies, an additional district road link is currently proposed, generally from the south and east, to intersect with EW-7 (Figure 12).

The road reserve widths presently selected are 40 metres for EW-7 and 45 metres for EW-8. It is intended that localised widening will occur to accommodate intersection designs and earthworked batters in conformity with similar arterial roads recently constructed within the North-West corridor.

The design of the Arterial Road will conform with the requirements of the Main Roads Department and the City of Wanneroo.

4.2.5 Services Conclusion

The subject land is capable of being supplied with all required infrastructural services. The servicing authorities have indicated that, where headworks are not in place, the scale of the proposed development would justify the development of the required systems. Negotiations are proceeding in this regard.

4.3 Environmental Planning and Design Considerations

In addition to the social and economic factors discussed previously in Sections 4.1 and 4.2, environmental planning and design will also receive detailed consideration in the development of detailed subdivision plans for the project. Environmental factors will be accommodated as far as can be practically achieved within the constraints imposed by the fundamental planning objectives of creating a low density urban development and making efficient use of the land in this regard. The design philosophies that will be incorporated in detailed planning, are summarised as follows.

4.3.1 Landscape

Existing landscape potential and the views of, and from within the site, are recognised as significant. The land is relatively high and views, particularly to the south west, are attractive. The existing tree cover over parts of the site is also appealing and it is important that suitable areas within the areas of public open space be retained by the Council for the enjoyment of both the residents and visitors passing through the area. Retention of existing vegetation will also assist in environmental management of the site.

4.3.2 Native Vegetation and Flora

Within Lots 1 and 2 Flynn Drive in particular, the subdivision plan will aim to preserve as much of the existing vegetation as possible within the 10% of the land that will be retained as public open space, and through other planning initiatives outlined below:

- The subdivision plan will preserve as much of the POS as practicable in naturally vegetated form, with appropriate management of fire, access and other aspects such as weed invasion and feral animal control. The need for open grassed playing fields to be provided for the community will also be recognised in this regard.

- Wherever engineering and construction constraints allow, vegetation will be retained on building lots.

- To the greatest extent possible, the shape of POS areas will be planned so that the ratio of boundary length to area is minimised, and "edge" effects are therefore also minimised.

- Recognising other planning requirements regarding location, naturally vegetated POS will be reserved to the greatest possible extent in a small number of large areas rather than many small areas, to reduce the boundary length to area ratio and to maximise the size and therefore future viability of vegetation reserves.

- The future developers of large lots created by subdivision for purposes such as schools and commercial centres, will be encouraged to retain the maximum possible area of natural vegetation within these lots, in preference to the establishment of manicured exotic gardens.

- Topsoil will be removed, stockpiled and spread on disturbed surfaces, where practicable.

4.3.3 Transition Zones

In response to concerns raised by members of the local community during recent consultations, the Development Plan has been modified to incorporate transitional allotments of 0.5 hectares adjoining the adjacent Special Rural suburb of Carramar Park. Abutting the Lake Adams Special

Rural suburb, an intensively vegetated strip is to be provided in addition to the 0.5 ha transitional allotments to ameliorate the possible visual impact of development.

4.3.4 Noise

Planning will seek to optimise, to the greatest practical extent, the location of residential areas, public open space and public facilities such as schools and commercial areas, to minimise the potential for occasional motor racing noise from motor sport facilities to the north of the site. In this regard, planning considerations will include:

- Location of high density residential zones away from the northern boundary.
- The future developers of large parcels of land for purposes such as schools and commercial purposes will be encouraged to retain as much as possible of the native vegetation within these lots, to assist in the attenuation of motor racing noise.

4.3.5 Drainage

Stormwater drainage from road pavements and limited flow from lots will be collected in trapped road gullies and directed via piped drains to drainage soakage basins, where recharging of the water table will occur, incorporating the following criteria:

- Wherever feasible the soakage basins will be located adjacent to areas of Public Open Space to aid screening the basins with landscaping.
- The open nature of the soakage basins provide for easy cleaning. Oils and other floating matter will be retained in the trapped gullies and will be removed during the Council's maintenance program.
- Soakage basins will be designed to meet the requirements of the City of Wanneroo.

4.3.6 Water Table Changes

Clearing of the native vegetation during construction followed by the establishment of urban structures will tend to increase aquifer recharge beneath the site, and will likely lead to a

localised elevation of the water table. Section 5.1.2 investigates potential hydrological impacts, and concludes that local water table rises are likely to be environmentally beneficial.

4.3.7 Aboriginal Mythological Sites

As noted in Section 3.3.6 a significant Aboriginal mythological site has been identified near the eastern boundary of Lot 2 Flynn Drive. This area will be retained as naturally vegetated Public Open Space.

4.4 Timing and Staging

4.4.1 Commencement of Development

It is anticipated that the initial stage of the development will be released onto the market towards the end of 1993.

4.4.2 Staging

The release of land for the residential housing market will follow a staged process to ensure that the provision of service and community facilities remains in step with the growth in population. To ensure that an even flow of land is made available in accord with fluctuations in market demand, it is estimated that approximately 600-800 lots will be released per annum over a ten year period.

Development will generally occur simultaneously on more than one front, to cater for various sectors of the perceived demand. The stages will be determined to a large degree by servicing requirements, but will generally develop from south to north in each land holding.

5.0 ENVIRONMENTAL IMPACTS

The development of the project site as an urban area will have impacts on the physical, biological and social environments both within the project site itself and to a lesser degree, within the immediate surrounding environment. This section of the report describes these environmental impacts so that they may be considered and assessed in comparison with the considerable benefits that the project will provide to the community, which are described in Section 2.0.

5.1 Physical Environment

5.1.1 Landform

The site does not contain any landform features that are of particular significance from a conservation or recreation perspective. The limestone ridge landform is continuous for a very large distance to both the north and south of the present site, and is a very common element of the broader suite of coastal landforms that occur within the metropolitan area and beyond.

For the most part, the gently undulating ridge and valley landforms that occur within the site are very well suited to urbanisation, and development can proceed with a minimum of earthworks. The overall topographic form of the land will not require substantial modification and the site will remain as a physically discernable component of the massive limestone ridge continuum, east of Wanneroo Road.

Some earthworks will be needed to achieve correct design specifications for the Arterial Road which will traverse the site.

5.1.2 Hydrological Impacts

5.1.2.1 Groundwater Levels

Urban development has the potential to change the long term hydrological equilibrium that exists within the underlying unconfined aquifer described in Section 3.1.4. The primary hydrological response to urbanisation observed on the Swan Coastal Plain is a rise in the average position of

the water table. The amount of water table rise has varied according to geographical and meteorological variation, and may reach 1-2 metres or more under extreme rainfall conditions.

Following urbanisation, three principal factors within the hydrological cycle are generally considered to contribute to water table rise. These are:

(i) Following the removal of vegetation, a reduction in the amount of rainfall that re-enters the atmosphere due to plant usage, and interception of rain by vegetation. This change causes an increase in the proportion of rainfall that can reach the aquifer and become groundwater recharge.

(ii) The importation and on-site use of water that may ultimately become aquifer recharge. The principal sources for imported water to enter the aquifer are septic tank/leach drain systems (which are not included in this proposal) and garden reticulation.

(iii) An increase in the proportion of rainfall that enters the aquifer as recharge, caused by the collection of stormwater from impervious shedding surfaces, and the concentrated discharge of this water to surface soils using infiltration devices such as soakwells and stormwater basins. Water applied to the soil in this way is much less influenced by evaporation and/or evapotranspiration, and because the soil that underlies the infiltration areas (soakwells, compensation basins) becomes fully saturated, downward drainage can occur more readily than if this water was applied over a very large area of soil.

In contrast, within the fringing rural areas of the northern Metropolitan area, factors exist which have the potential to reduce groundwater levels. These include:

- groundwater abstraction for public water supply;
- groundwater abstraction for horticultural irrigation, and
- silvicultural (tree farming) practices within CALM estate.

In terms of environmental impact assessment, prediction of water table rise due to urbanisation of land that is located within an area that has previously undergone development for horticultural and silvicultural purposes, is a complex matter. Furthermore, it is generally accepted that

variation in rainfall is the primary factor affecting groundwater level, rather than land use. Therefore additional complexities arise due to short and long term shifts in the average position of the water table that may occur in response to climatic variations.

Recognising the many factors that may affect groundwater levels, to gain an informed perspective of the potential magnitude of the local water table rise that may be expected to follow urbanisation of the project site, it is necessary to examine:

(a) The present status of the local unconfined aquifer (in the context of the effects that previous and current land uses have had on the local hydrological regime);

(b) The anticipated effects of current and proposed abstraction schemes and pine plantation management on the local hydrological regime, and

(c) The anticipated effects of proposed urban development of the region, including the development of the project site as proposed herein.

The above aspects are discussed in further detail in the sections below.

(a) The effects of past and existing land uses and developments

In 1986 the Water Authority of Western Australia released an Environmental Review and Management Program (ERMP) for a proposed management plan for the Gnangara Mound groundwater resources (WAWA, 1986). The ERMP was prepared as a result of a proposal by the Water Authority to establish a Public Water Supply Scheme based on groundwater abstracted from the unconfined aquifer around Lake Pinjar. As the proposal had potential to detrimentally affect local wetlands through water table lowering, the ERMP carefully examined both previous groundwater level changes and predicted future groundwater levels by computer modelling of the aquifer.

Information presented within that document (and reproduced here) indicates that average groundwater levels in the general vicinity of the present project site had generally fallen by up to approximately 1.0m during the 10 year period between 1976 and 1985. The degree of water table change varied with specific locations as shown on Figure 13, which deals with the period 1976-85.

Figure 13 shows that the position of the water table in 1985 within the specific project site was approximately 0.5m lower than in 1976. Lake Adams, which is located directly east of the site, had experienced a water table fall of approximately 0.7m, whilst Lake Joondalup, located to the south-west of the site, experienced a fall in the average water level in the order of 0.5m. For the longer period of time from 1969-1986, Lake Joondalup has experienced an overall fall in water level of more than 1m (Figure 14), whilst Figure 7 shows that Lake Adams has undergone a similar fall in water level over the same period of time.

The decline in groundwater and therefore wetland water levels that occurred during this period may be largely attributed to extended lower-than-average rainfall, however it is evident that the following factors also contributed to lowering of the water table:

- Groundwater abstraction for public water supply via the Wanneroo Groundwater Scheme;
- Development of market gardens and orchards and accompanying abstraction of groundwater for irrigation water supply;
- Abstraction of groundwater for private domestic water supply, and
- Reduction in groundwater recharge beneath CALM's State forest 65 as a consequence of increased evapotranspiration and rainfall interception that accompanied establishment of the pine plantations.

(b) Effects of future abstraction schemes and pine plantation management initiatives

The project site is located in an area where a variety of impending land use proposals will have a complex effect on regional groundwater levels. In response to management commitments made in the Gnangara Mound Groundwater Resources ERMP, the Water Authority conducted a review of groundwater availability within the Wanneroo area (Miotti and Hopkins, 1989). The objective of the review was to examine and re-assess the individual and cumulative impacts of public water supply abstraction in the context of the various relevant land use changes that are likely to occur within the area. These data were required to provide guidance as to how groundwater should be managed so that specifications for minimum acceptable water levels for the region's wetlands, set by the Minister for Environment in response to the proposals within the Gnangara Mound ERMP, could be maintained.

The study utilised a sophisticated computer model to generate a series of water table contour predictions for the Wanneroo region. The most important land use proposals that were examined by the review, and corresponding water table changes that were predicted by the computer model, are explained below and are particularly relevant to assessing the impact of urbanising the project site:

- The Water Authority has installed Stage 1 of the Pinjar Groundwater Scheme, which will abstract a maximum of approximately 6,000ML/annum, and has plans to establish Stages 2 and 3, which will increase total abstraction to approximately 14,000ML/annum. The combined effect of current and proposed future abstraction from Stages 2 and 3 will be to lower groundwater levels beneath the site by approximately 0.2m.

- For the Wanneroo Groundwater Area, which the site is located within, the Water Authority proposes to increase the interim limit for private groundwater abstraction (largely market gardens) from the present level of 36,000ML/annum (which is presently 85% utilised) to a limit of 41,000ML/annum. The individual effect of the proposal to increase private abstraction limits will be to lower groundwater levels in the Wanneroo Groundwater Area. If the increased limit was to be fully utilised, groundwater levels beneath the site would fall by approximately 0.8m.

- Following the Water Authority's commitments regarding management of groundwater in the Gnangara Mound Groundwater Resources ERMP, CALM (in consultation with the Water Authority) will manage pine plantations within State Forest 65 to maximise groundwater recharge by thinning existing pine plantations to achieve a basal area of between 7-15m^2/ha. At March 1989, CALM had already commenced thinning operations, initially concentrating on the area east of Jandabup Lake. The effect of this management strategy will be to increase groundwater levels within State Forest 65 and peripheral areas. It is anticipated that groundwater levels beneath the present site will rise by approximately 0.5m.

In summary, under average rainfall conditions, it is projected that the abovementioned proposed developments will, in combination, reduce current groundwater levels beneath the project site by approximately 0.5 metres.

(c) Effects of urbanisation proposals

Two approaches have been adopted to assess the likely effects of this urbanisation proposal on the groundwater regime. These are listed as follows and the results summarised below:

- Estimation of the water balance for the project site before and after development, to assess the relative changes in groundwater recharge following urbanisation.

- Review of the Water Authority's projections for changes in water table levels, which are based on sophisticated modelling techniques, for different urban development options in the locality.

Pre- and post-development water balances for the project site have been calculated and are presented in Appendices A and F, respectively. The water balances include quantitative estimates of groundwater recharge and abstraction, which are used to derive a 'nett recharge' estimate for the site before and after development. A range of estimates has occurred because some of the critical parameters in the calculations can not be precisely determined, but are based on local scientific research results which indicate the most likely range in values for these parameters.

The comparison of pre- and post-development water balances indicates that urbanisation is most likely to increase the nett groundwater recharge beneath the site, by a factor between 9% and 99% (refer Appendix F). Consequently, the average position of the water table should rise, although it is not possible to define the associated extent of water table rise using the simplified water balance approach presented in Appendices A and F. However, the estimates of nett recharge indicate that a substantial increase in groundwater recharge may occur, which is consistent with past experience on the Swan Coastal Plain where a rise in the water table has occurred following urbanisation.

Whilst the local water table rise which could be attributable to this development proposal has not been determined, modelling conducted by the Water Authority (Miotti and Hopkins, 1989) has predicted the likely changes in groundwater levels that will accompany urbanisation proposals within the Wanneroo area. The urbanisation proposals include the project site, but the modelling exercise did not specifically consider this site in isolation. These urbanisation proposals are identified below, along with the predicted effects on groundwater levels.

- The State Planning Commission's (now the Department of Planning and Urban Development) proposals for urban development in the Wanneroo area (SPC, 1987), which were based on the Corridor Review Group's reassessment of the MRS. These urbanisation proposals have been reaffirmed in the recent Urban Expansion Policy Statement (DPUD, 1990b) and include the present development proposal. The modelling study described above concluded that this urban expansion in the Wanneroo area would increase groundwater levels beneath the present site by approximately 0.5m.

- In response to requests for comment on the Review Group's proposed MRS amendments, the City of Wanneroo prepared an alternate plan for urban development within the City. The anticipated effect of these development proposals would be to increase groundwater levels beneath the present site by approximately 0.9m over the 20-30 year development schedule.

In conclusion, urbanisation of the project site and nearby rural land in accordance with the above development concepts would tend to increase groundwater levels beneath the project area by 0.5 to 0.9m. This change is anticipated to occur over the next 20-30 years, and will moderate and/or negate the fall in groundwater levels that is likely to be caused by future groundwater abstraction in the area. Additionally, the nett water table rise that may occur (up to 0.4m) may compensate for the general decline in groundwater levels that has occurred beneath the site since the early 1960's.

5.1.2.2 Groundwater Quality

Urbanisation of land is known to result in changes to the quality of underlying groundwater, through the transport to the aquifer of contaminants including fertilisers, garden and household chemicals, and oils and greases. The acceptability of groundwater quality change may be gauged by the type and degree of change that is likely to occur, and the effect(s) on the aquifer's uses.

The following sections summarise the possible sources of groundwater contaminants within the site following urbanisation, briefly examine the role of regulatory control instruments, and conclude that significant changes to groundwater quality, to the detriment of the principal beneficial uses, (irrigation and maintenance of regional wetlands) are unlikely.

(i) Domestic Sources

The provision of reticulated sewerage throughout the development will be the major factor in reducing domestic contaminants within the site, as leachates from septic tank/leach drain systems are the primary contaminant source to groundwater beneath urban areas of Perth.

However, other contaminant sources not reduced by deep sewerage include:

- garden fertilisers,
- garden and household pesticides and herbicides,
- oil, grease and metal contaminants from road runoff.

Experience in other parts of the Metropolitan area suggests that because sewage will be transferred off site for treatment and disposal, the contaminant loading from the remaining potential sources will be relatively small. Additional relevant factors including:

- the water table is relatively deep, averaging 25m below ground surface,

- the shallow sediments are calcium carbonate (limestone) rich and can remove many contaminants from infiltrating water,

indicate that normal domestic sources do not appear to present significant risk of groundwater quality changes, to the detriment of beneficial uses.

(ii) Commercial and Other Sources

The principal sources of groundwater contaminants from commercial land uses of the type envisaged for this area, are oil, grease and metal contaminants from road runoff, and pesticides used in building construction and maintenance. In general terms, these sources are not considered to be of high significance due to the low intensity of landuse and the prevailing subsurface conditions, as previously noted. The use of trapped road gullies in kerbed roads will reduce the likelihood of oil and grease reaching the drainage soakage basins.

Other sources of contaminants include building and horticultural chemicals and fertilisers from the proposed schools and public open space areas. Commercial sources are expected to be

comparatively small, however efforts to minimise contaminant loadings from these and all other potential sources will be implemented, as described under Environmental Management (Section 6).

(iii) Land Use Control for Groundwater Protection

Following subdivision, proposals to establish land uses or commercial activities that could potentially risk groundwater quality will be referred to the Water Authority in the course of the normal planning and building approvals process, and will be subject to appropriate control and licensing.

(iv) Beneficial Uses

Recognising the surrounding land uses and the local environment, the principal beneficial uses of the aquifer may be considered to be;

- for market garden reticulation
- for environmental maintenance, principally of wetland ecosystems (see Figure 15, which defines beneficial uses for adjacent areas of the Gnangara Mound).

The development will be reticulated with potable water from the Water Authority mains system, therefore abstraction of groundwater for potable consumption is not required.

A recent study of the concentration of soluble contaminants in groundwaters underlying urban areas of varying age within northern Perth (Gerritse *et al.*, 1990), found that groundwater quality was within potable standards in all cases. Whilst urban areas with poor groundwater quality are known within the Metropolitan area, these are mainly associated with on-site septic tank systems for the disposal of effluent in areas with very shallow water tables.

These data, together with the conclusions regarding contaminant loadings projected for the development, indicate that groundwater beneath the site is likely to remain at potable standard, and hence will not be affected with regard to it's suitability for irrigation.

Groundwater quality changes that could be detrimental to nearby wetlands, to which a portion of

groundwater underlying the site could ultimately flow, are also unlikely. Lake Joondalup is hypereutrophic (nutrient enriched) with respect to both total phosphorus and total nitrogen for the majority of the year (Davis and Rolls, 1987), and therefore additional loading should be avoided. Lake Joondalup is not in the direct flow path of the site, and would receive only a small amount of water from this part of the local aquifer.

The wetland opposite the site, near Burns Beach Road, is in the flowpath of the site's underlying groundwater and may experience minor water quality changes. However, on the basis of the anticipated low nutrient loadings within the site, and recognising the protective ability of the shallow limestone sediments, these water quality changes are not expected to cause significant detriment to the wetland.

5.1.3 Noise

The generation of noise from a range of local sources will influence existing residents in surrounding Special Rural areas and future residents of the urban development.

Noise will be generated from the sources listed and described as follows:

(i) Motor Sport Venues

The location of the proposed development in the proximity of the motor sport venues detailed in Section 3.3.5 will result in the periodic reception of noise within the project area. Noise measurements conducted within the site while racing activities were in progress showed that noise levels in certain parts of the site can be higher than the recommended criteria outlined in the Environmental Protection Act, 1986 (Noise Abatement Regulations) Assigned Outdoor Neighbourhood Noise Levels in various categories. However, it should also be recognised that background noise levels recorded from the site at present also exceeded these criteria, predominantly due to fauna and wind.

As would be expected, noise levels recorded at the northern portion of the site closest to the motor sport venues were higher than those recorded at the south of the site, due to the closer proximity to the source of the noise. It is not possible to predict the effect of urbanising the site on noise transmission from racing activity. However, assuming that noise levels emitted from the motor sport venues do not decrease, then it would be expected that some portions of the

proposed development, particularly in the north, may receive weekend outdoor noise levels (Lmax) in excess of recommended criteria by approximately 5-10 dB(A) when the venues are periodically in operation.

(ii) Construction Phase of the Urban Development Project

As with all residential development, the establishment of services will require the use of heavy machinery. Noise generated by machinery operation will be mitigated by the following factors:

- the presence of vegetation within the Special Rural zones,
- the retention of vegetation areas on site,
- the gradient of the land, which will tend to shield some residential areas from the effect of the operations,
- the restriction of the operation to daylight hours, and
- the use of noise reduction devices on all equipment.

Noise generated by machinery during the construction phase will occur over a relatively short period of time. The project is to be implemented over a 10 year time span, and will involve a series of clearing and construction operations in a staged program, rather than a single extended campaign.

(iii) The Establishment of the Major Road System

Three major road systems will be established within the proposed development area. These are EW-7, which will connect Burns Beach Road to Neaves Road, the upgrade of Flynn Drive (EW-8), and an easterly connection to EW-7 (Figure 12). The construction and utilisation of the road systems will occur over an extended period of time, as demand for an expanded road network within the North-West Corridor is established.

The establishment of these three major roads will result in an increase in the line source noise level generated by vehicle movement.

In certain areas dictated by topography, the new roads will be located within a cut, below natural ground level, to achieve the required horizontal road geometry for the design speed. This will act to reduce noise propagation to adjacent areas.

DPUD currently requires that boundary fencing to major roads be installed where lots back onto or abut a major road.

5.2 Biological Environment

Recognising the present condition of the site with respect to biological resources, the present assessment of biological impact is confined to naturally vegetated areas within Lots 1 and 2 Flynn Drive, as the biological value of land within Location 2579 is demonstrably minimal.

Urban development of the project site will require removal of most of the existing vegetation. In accordance with current planning policy, 10% of the nett residential development area will be retained as public open space reserve. Recognising other important community needs for active recreation and open space, and the requirements of the City of Wanneroo, the public open space reserves within Lots 1 and 2 Flynn Drive will be retained in their present naturally vegetated form to the greatest extent possible, and managed accordingly.

For the balance of Lots 1 and 2 Flynn Drive, removal of a considerable proportion of the existing vegetation will be necessary to enable urban development to proceed. This section examines the impact of this loss of vegetation and habitat, from both local and regional perspectives.

5.2.1 Vegetation and Flora

To gain a balanced appreciation of the impact of clearing within Lots 1 and 2 Flynn Drive, it is necessary to examine the importance of the vegetation and flora from both regional and local perspectives with particular reference to the degree to which the types of vegetation structures and flora that presently exist within the site, are represented elsewhere in secure conservation reserves.

5.2.1.1 Regional Perspective

As noted in Section 3.2.2, the natural vegetation that occurs within the project site has been classified as Karrakatta Central and South Complex. This vegetation complex is distributed in a narrow band along much of the length of the Swan Coastal Plain, from the project site (which occurs near to the northern extent of this vegetation complex's distribution) to areas south of Bunbury.

Many of the areas that formerly supported Karrakatta Central and South Complex have now been cleared and developed. However, the Karrakatta Central and South vegetation complex is also represented in regional conservation reserves.

In terms of the conservation reserves of the region, it is necessary to assess the site in relation to the Department of Conservation and Land Management's (CALM) Northern Forest Region Regional Management Plan, 1987 - 1997 (see CALM, 1987).

The site lies within the Wanneroo District, which is the most northerly district of the region. Its principal operations are the management of softwood forests *(Pinus pinaster)*, water production from the Gnangara Mound, recreation and conservation. Both Yanchep and Neerabup National Parks are within this district.

Sixteen CALM conservation reserves are proposed, in addition to those already established, for the conservation of vegetation type and/or special features.

Table 6 shows those proposed reserves which have a vegetation type similar to the habitat represented by the subject site, i.e. dominated by *Banksia* and Jarrah-*Banksia* woodlands and *Melaleuca* damplands, with associated Marri and Flooded Gum, which occur in the Wanneroo District and the proposed area of each reserve.

Table 6 demonstrates that as at 1987 there were approximately 20,000 ha of reserves within the Wanneroo District specifically for the proposed conservation of *Banksia* and associated woodlands. This does not include existing reserves in which *Banksia* woodland, whilst present, is only a minor proportion of the vegetation complex, e.g. Gingin-Boonanarring, 10,100ha, vegetation type - jarrah, marri, *Banksia.*; Yurine Swamp, 20ha, vegetation type - Paperbark, flooded gum, *Banksia*; Bambanup, 90ha, vegetation type - jarrah, marri, *Banksia*, paperbark.

Table 6

Proposed Conservation Reserves in the CALM Wanneroo District

Name (or locality)	Area (ha)	Vegetation Type
Mogumber	160	*Banksia*
(Nabaroo)	10	*Banksia*
(Yeal Lake)	340	*Banksia*, paperbark
(Gingin Stock Route)	60	*Banksia*
Jandabup	240	*Banksia*
(Yeal Swamp)	10,700	*Banksia*, paperbark, jarrah, marri
Caraban	5,500	*Banksia*
Melaleuca Park	3,200	*Banksia*, paperbark
Total	**20,210**	

(after CALM, 1987)

Within the CALM Wanneroo District there is, therefore, a significant area of land for which the principal use is the conservation of *Banksia* woodland, and the fauna which utilise this complex as habitat.

Additional to the large area of *Banksia* reserve proposed by CALM, it is important to note that an environmental audit of the northern corridor carried out for CALM by the Semenuik Research Group in 1991, did not identify the present site as an area of significant conservation value (DPUD, pers. comm., 1992).

Singleton (EPA, pers. comm.) reviewed the degree to which vegetation complexes identified for the Darling System by Heddle *et al.* (1980) were represented in Metropolitan System Six Reserves as recommended by DCE (1983), and found that 15 System Six recommendation areas totalling approximately 5,500 ha in area contained 17 areas of Karrakatta Central and South vegetation complex. It should be noted however, that this area represents the total reserve area and not the area of Karrakatta Central and South vegetation present.

According to the Darling System vegetation mapping, this vegetation complex occurs in three additional country System Six recommendation areas. Table 7 lists the System Six recommendation areas which contain Karrakatta Central and South complex.

From a regional perspective, this vegetation complex therefore appears to be relatively well represented in existing reserves.

There are also substantial areas of Karrakatta Central and South complex in private land holdings along the south-west coast. It is not permissible to clear areas greater than 1 ha in size without notification to the Commissioner of Soil and Land Conservation, in accordance with the Soil Conservation Act, 1944. Following notification, the site is inspected and the landowner may be required to enter into a Reserve Agreement, or receive a Soil Conservation Notice to prevent clearing, depending upon the characteristics of the site. Vegetation may also be protected under the Department of Agriculture's Remnant Vegetation Protection Scheme.

Therefore, examples of this vegetation type within private ownership are protected from clearing by conservation legislation. Although the conservation of these areas may still not be assumed, it is likely that at least fragmented portions will persist, particularly within areas of rural and Special-Rural land zonings.

In the vicinity of the present site there are two areas where development has proceeded whilst retaining significant proportions of natural vegetation. Within the Carramar Heights Special Rural area, approximately 75% of the natural vegetation remains, and whilst in variable condition predominantly includes both the understorey and overstorey, within large rural-residential lots.

Within the Wanneroo Golf Course approximately 10% of the natural vegetation remains. For both of these developed areas, the presence of the natural vegetation is fundamental to their intended function, and it is therefore likely that these stands will persist.

5.2.1.2 Local Perspective

A number of other stands of Karrakatta Central and South complex of various size occur in the vicinity of the site, within the following locations:

- Location 2706 Clarkson Avenue (approx 75ha)

Table 7

System Six Areas Containing Karrakatta Central and South Vegetation Type

	METROPOLITAN
M7	Lake Joondalup and Goollelal
M11	Warwick Woodland
M12	Marangaroo
M37	Carine Swamps
M38	Careniup Swamps
M39	Lake Gwelup
M40	Dianella Open Space
M42	Jackadder Lake Woodlands
M47	Bold Park
M49	Kings Park
M63	Harry Sandon Park, Attadale
M64	Wireless Hill Park, Ardross
M66	Mt. Henry, Manning
M93	Cockburn Wetlands - Eastern Chain
M104	Leda

	COUNTRY
C54	Yalgorup National Park
C55	Clifton Management Priority Area
C57	Myalup Management Priority Area

- Lot 11 Carramar Road (approx 60ha)
- Reserve 834 and 812 Wanneroo Road
  [opposite Lake Joondalup (approx 15ha)]
- Small lots between Mariginiup Lake and Lake Adams and east of Pinjar Road (approx 20-30 ha)
- Land north of Flynn Drive and east of Mather St (approximately 180 ha)
- Land to the immediate west of Wanneroo Road opposite Loc 2579 (small)
- Reserve 27294 south of Clarkson Road (small)
- Reserve 26542 Pinjar Road (small)
- Lot 39 Pinjar Road (small).

The above areas have been estimated by interpretation of colour aerial photography flown in December 1989, at a scale of 1:20,000. Only discrete areas of Karrakatta Central and South vegetation complex were included.

The data presented above leads to the conclusion that although a large single coherent stand of Karrakatta Central and South vegetation complex will be cleared to enable development to proceed, there are a number of other remnant stands of the vegetation type within the vicinity that are not affected by this proposal, and additionally some represented within secure reserves.

5.2.1.3 Rare And Restricted Flora

The evaluation of rare and restricted flora on the Northern Swan Coastal Plain conducted for the Gnangara Mound ERMP (Water Authority Western Australia, 1986) identified seven species of plants that are likely to occur in wetland habitats and six species of plants occuring in *Banksia* woodland.

As the site contains only a very small area of seasonal wetland and no permanent lakes, it is

unlikely that any rare or restricted wetland flora would be found within the site boundaries. The occurrence of the dampland in the south eastern corner of the site may have been a suitable location for remnant wetland species however its isolation from the wetland through the construction of Clarkson Avenue and its degradation through past clearing and grazing practises would most likely preclude the occurrence of rare or restricted wetland flora.

Of the six rare and restricted plant species that are known to occur within *Banksia* woodland habitats, three are unlikely to occur on site as their known distributions do not coincide with the geographical location of the site. The remaining three woodland species are all known from the Bassendean Vegetation Complex, and as the site is within the Karrakatta Central and South complex, there is a low probability of occurrence.

Through the assessment of existing habitats and plant species distribution recorded from the region and from direct survey of the site, it is considered unlikely that any rare or geographically restricted flora could be found on site.

5.2.1.4 Dieback

The introduction of the dieback fungus (*Phythopthora cinnamomi*) to the existing stands of native vegetation has the potential to degrade the quality of the public open space areas that are retained as vegetation reserves.

The dieback fungus proliferates in the soil when conditions of moisture and warm temperatures are combined. Transportation of the fungus occurs during the winter months when soil moisture necessary for movement of the fungus is readily available.

The highly permeable nature of the underlying sands on the site does not allow the formation of permanent surface drainage lines, therefore if the fungus was imported to the site the risk of spread would be considered low, provided that appropriate hygiene procedures were employed during the implementation/construction phase of the project. These procedures would only be necessary if construction vehicles were travelling to dieback contaminated areas and then re-entering the site.

5.2.2 Habitat and Fauna

The establishment of the proposed residential housing development will involve clearing most of the native vegetation from Lots 1 and 2, altering the existing habitat for ground-dwelling mammals and reptiles, and modifying available bird habitats.

The clearing of Loc. 2579 will have a very much smaller effect on the existing habitat, as this area has been extensively degraded through grazing on the remaining stands of native vegetation and broad-scale clearing.

The presence of fauna within the study area was determined by assessing habitat availability and by reference to the scientific literature in regard to previous surveys carried out in nearby reserve areas, as previously described in Section 3.2.

The impact of the development on the native fauna will occur through:

(i) Displacement or loss of species

The extensive clearing operation, which will occur principally on Lots 1 and 2, will generally result in the loss of the resident species which tend to be habitat specific, relatively immobile, and species which have a limited territorial range such as some reptiles. Other more mobile fauna, such as birds, kangaroos and wallabies, will be better able to relocate to adjacent suitable habitat.

(ii) Habitat pressure following relocation.

Removal of habitat will result in the relocation of mobile species into surrounding woodland areas to the north and west and will place additional pressure on the populations that already exist in the surrounding areas as competition for resources increases. The displacement of species will occur on a gradual time scale, as the implementation of the project will occur over approximately 10-12 years.

The impact of the clearing operation on fauna will be reduced by the maximised retention of faunal habitat areas within public open space, school sites, and within the grounds of community facilities, as far as is practically possible. These island reserves will provide habitat

for species such as reptiles which have a limited territorial range, providing the reserves are retained in as near natural condition as possible.

The gradual relocation of species and the retention of native habitat within a range of reserves and naturally vegetated areas within the site will assist in minimising the detrimental impact of development on the fauna.

5.2.3 Wetlands

The projected increase of water levels within adjacent wetlands, specifically Lake Adams and Lake Joondalup, is considered to have potential for beneficial effects, as historical water level data for the local aquifer and for these wetlands have generally shown a decline in the order of 1.5m over the last 15-30 years.

The possible effects of increasing local wetland water levels is discussed below.

5.2.3.1 Lake Adams

An analysis of water level readings that have been recorded over the past 30 years indicate Lake Adams has experienced a decline of approximately 1.4 metres (Figure 7). This is believed to be a result of groundwater abstraction for horticulture, and the establishment of pine plantations in State Forest No. 65. During this period of water level decline, there has been a gradual inward advancement of the fringing *Eucalyptus rudis* (Flooded or River Gum) vegetation from the previous high water mark to the present inundation level.

The prediction of a rise in the water level of approximately 1.1 metres (WAWA, 1989) due to factors such as the effect of urbanisation proposals for Wanneroo and the influence of forestry management practices in the adjacent pine plantations, will lead to the inundation of the juvenile *Eucalyptus rudis* but would not be expected to inundate the mature trees that fringe the lake. *Eucalyptus rudis* is tolerant to seasonal inundation, however extended inundation may lead to eventual plant death, depending on water depth and inundation period.

An increase in Lake Adam's water level, returning to seasonal depths closer to historic levels, would lead to a shift in the distribution of vegetation types. This would include an increase in the area of open water, and the outward expansion of fringing reed vegetation and flooded

gums. As water level changes are likely to occur gradually, over a period of many years, adaptation to higher water levels by affected stands of vegetation will be possible, as was adaptation to lower water levels during previous years.

Increased waterfowl usage and changing patterns of utilisation, including probable improved function for drought refuge, would also be expected to accompany water level increases within the wetland. A dilution effect, in terms of nutrients and salinity, could also be expected to occur in the wetlands, which may reduce eutrophication and its effects to some degree.

5.2.3.2 Lake Joondalup

An analysis of water level readings that have been recorded over the past 20 years, indicates that the average level of Lake Joondalup has also declined by approximately 1.4 metres (see Figure 14), whilst data presented in WAWA (1989) predict a possible groundwater level increase of 1.0 to 1.5m resulting mainly from urbanisation proposals and forestry management practice in State Forest 65. The predicted rise in the water level will again result in a return to the regime more consistent with historical water levels.

The lake is fringed by emergent sedges at the waterline, then by paperbarks (*Melaleuca rhaphiophylla*) and Flooded Gum (*Eucalyptus rudis*) vegetation. The fringing vegetation extends from between 20 to 80 metres beyond the waterline and then grades into a Tuart/Marri overstorey beyond the 20m AHD contour. A water level rise in the lake may lead to the inundation of the innermost zone of the fringing vegetation but would not be expected to encroach upon the Tuart/Marri woodland as the rise would be mitigated by adjoining caves in the coastal limestone, which are thought to act as spillways thus controlling water levels (Allen, 1981).

Past experience has shown that vegetation has been able to adapt to a lowering of the average groundwater table within the Wanneroo area. This is typified by the adaptation of Lake Joondalup to lower water levels, and by the inward colonisation of Flooded Gums at Lake Adams. Similarly, it may be expected that the vegetation communities may adjust to a rise in water levels approximate to former levels, provided the rise occurs over an extended period of time as predicted.

5.3 Social Environment

5.3.1 Landscape

5.3.1.1 Regional Landscape

The establishment of urban land uses and associated physical structures within the site will cause a shift in the characteristics of the regional landscape. As noted in Section 3.3.3, the site is located in a region in which the general physical elements and aesthetic characteristics of the landscape reflect a change from traditional suburban residential land uses to a semi-rural/rural landscape based on horticultural land uses, including low density residential areas offering a semi-rural lifestyle.

Urbanisation within the site will extend the apparent north-eastern boundary of suburban landuse by the creation of a new, more northerly urban cell visible from adjoining roads including Wanneroo and Pinjar Roads, and Clarkson Avenue. The present rural/woodland landscape presented by views of the site from these regional roads will change to a more traditional new urban landscape.

Whilst approximately 7.5 km of adjacent roads will be affected by landscape change resulting from this development proposal, it is important to recognise that there are other land use factors which will mitigate this change in both the short and long term.

The forest/woodland landscape presented by Neerabup National Park, which lies adjacent to the western boundary of the site, will remain as an important regional landscape element in the longer term.

Similarly, on the Pinjar Road boundary north of Neaves Road, pine plantations within State Forest 65 will continue to exist for the foreseeable future so will also be a more constant element in the landscape.

To the north of the site along the Wanneroo and Pinjar Road frontages, land uses and therefore the landscape, will generally remain in their present form for approximately the next 25-30 years, according to the Urban Expansion Policy for the Metropolitan Region (DPUD, 1990b).

In the close vicinity of the site's northern boundary, development of the Flynn Drive Industrial Estate will consolidate the northern extent of "built-up" land but will not discernibly affect landscape views from the existing major regional roads.

Although land to the south of the site, towards the Wanneroo townsite, is proposed for urbanisation, it is anticipated that the process of urban development in these areas will proceed very slowly.

In summary, the regional landscape character will experience change as a result of progressive urban development, and will reflect the extension of the current limit of suburban land use. However, landscape changes caused by this development proposal will be mitigated by fixed land uses and landscape elements presented by National Park to the west, State Forestry to the north-east, and rural/semi-rural/forest land uses to the more distant north.

Changes to the landscape have been common in recent years within the northern parts of the north-west corridor. This project will present similar landscape changes, but these changes will be softened by the continuation of current land uses within many surrounding areas, for the foreseeable future.

5.3.1.2 Local Landscape

The current contribution of the site to the local landscape will also change following development, with principal changes summarised as follows.

(i) Wanneroo Road

To the east of Wanneroo Road, the land surface slopes upwards in a ridge formation and the visual penetration of the site is limited to the near foreground.

Following development, the current landscape views (described in Section 3.3.3 and Appendix B) will be replaced by those of a typical new residential area featuring a combination of houses, roads, commercial areas and public open space reserves. Initially, the development area will have the characteristic appearance of a new residential estate, however the growth of private gardens, together with landscaped areas within road verges, public reserves and commercial areas, will soften this appearance. With time, the Wanneroo Road visual aspect will appear as

an established continuation of the urban landscape that already exists further south at the Wanneroo townsite.

It is important to note that land to the west of Wanneroo Road, opposite the site, will either remain in its present form or be incorporated into Neerabup National Park according to System Six Recommendation M6 (DCE, 1983). The landscape change resulting from this development proposal will be balanced in the longer term by the retention of the natural woodland, forest and wetland vegetation on this adjacent land, combined with horticulture on the western side of Wanneroo Road. From a local and regional perspective, Neerabup National Park and the public open space at Lake Joondalup (proposed Yellagonga Regional Park), will continue to be a dominant element in the local landscape.

(ii) Clarkson Avenue

Views across the site to the north from Clarkson Avenue are similar to those from Wanneroo Road, although somewhat longer views are afforded by the topography. Change to the landscape following development will be in the form described for Wanneroo Road.

However, as plans for land to the south of Clarkson Avenue consist of additional future rezoning to "Residential" (DPUD, 1990c), the present rural landscape will change, however over a longer and more gradual time frame.

(iii) Pinjar Road

Views across the site to the west from Pinjar Road have two components. In the southern portion, views across the site are equivalent to those from Wanneroo Road and Clarkson Avenue, where an urban landscape will replace the current open landscape of abandoned pasture and scattered regrowth.

In the northern portion, the present views of natural vegetation will be replaced by an urban landscape which with time will soften to that of an established suburban area.

Removal of the woodland vegetation will provide more visual penetration of the site from Pinjar Road. In some places the views of topographically higher land located centrally within the site will add a further dimension to the present landscape.

With regard to Wanneroo Road, current plans for land to the east of Pinjar Road are for continued rural zonings, with areas of pine plantation (State Forest 65) north of Neaves Road. This landscape will therefore remain relatively unchanged.

(iv) Flynn Drive

The Flynn Drive end of the site will likely be the last portion to be developed, and major landscape changes may not occur for some 10-12 years. Ultimately however, the present short-distance views into the site of forest/woodland vegetation, will be replaced by urban views as described in paragraphs (i) - (iii).

In total, the landscape changes which will accompany development of the site will be consistent with landscape change throughout much of the Metropolitan area where urban expansion at the fringes of the current "built-up" areas replaces old, disused or minimally utilised agricultural lands and natural vegetation.

Consistent with current trends in urban design, the impact of the urban landscape will be softened by the retention of as much native vegetation as possible during earthworks, the establishment of landscaped areas based on indigenous flora, and the retention of natural vegetation within public open space reserves and residential allotments, to the greatest possible extent.

5.3.2 Ethnographic Impacts

A site of ethnographic significance related to the mythological presence of honey possums is located within Lot 2 Flynn Drive in a seasonally wet depression opposite the junction of Pinjar Road and Lee-Steere Drive. The site was identified following a visit to the area by an Aborigine considered to have a wide knowledge of local Aboriginal cultural aspects.

Consultations with the Aboriginal custodians of the site determined that a specific area should be protected from development through the establishment of a secure reserve. The establishment of such a reserve will ensure the maintenance of the existing habitat and resident faunal populations, and will preserve the link between the present and the past culture of the Aboriginal community.

As noted in Section 4.3, 10% of the nett residential area will be given up by the proponents free of cost for the provision of public open space. To achieve the protection of the site, it is anticipated at this stage that an area of land relating to the mythological honey possum site will be contained within a proportion of the required public open space and reserved for such a purpose. The size and exact location of the reserve has been determined following consultations with the proponents and the Aboriginal custodians of the site, and has been incorporated into the Development Plan. Figure 12 shows the reserve area currently proposed.

5.3.3 Rural Lifestyles

The expansion of urban growth within the whole of the north-west corridor, the establishment of urban land uses within the present site over a 10-12 year period, an increasing local population and the shift in the nature of the local population's day to day activities occurring as a consequence of urbanisation, will gradually change the present rural character of the immediate locality.

The degree of change is difficult to precisely characterise as the present contribution of the site to the rural character of the region and locality is limited, and degree of change is largely subjective. As noted in the previous section regarding landscape, whilst land use changes visible from the (approximate) 7.5km of roads directly adjacent to the site's boundaries will gradually occur, there are several other local components which also contribute to the rural character of the area, including Neerabup National Park and State Forest 65, which will remain as fixed land use/landscape elements for the foreseeable future. These areas will reduce the degree of apparent change to the landscape which will result from this proposal.

Two areas in the immediate vicinity of the site, Lake Adams and Carramar Park, have been developed for residential living in a rural setting. At Lake Adams the focus of the estate's rural character is the lake itself, the open farmland at its periphery, and the pine plantations to the north. The land within the Lake Adams development slopes to the north and east and provides views over the lake, the plantation and other rural lands to the north, east and south east. The present proposal will not impinge on these important views.

At Carramar Park, the focus of development is residential living within a natural forest setting. Houses have been set back from the internal roads to obtain seclusion, using the forest vegetation as a visual screen. Development of urban land uses within the present site will not

impinge on landscape values within Carramar Park, as the new developments will not be visible except at the boundaries of directly adjoining properties.

The need to accommodate rural lifestyles within the north-west corridor has been recognised by the Department of Planning and Urban Development in the formulation of the North-West Corridor Structure Plan (DPUD, 1991a). There are substantial land allocations within the structure plan for rural land uses and "landscape protection", centred on the Lake Pinjar area and around the circular lakes to the south, including Lake Adams, Mariginiup Lake, Lake Jandabup and Gnangara Lake.

Road traffic levels are a further determining factor in the rural character of the area, and road traffic concerns by residents in the Lake Adams area have previously been noted by a DPUD-coordinated Committee with local resident and Council representatives. Traffic studies have been carried out for this proposal with the objective of minimising increases to traffic levels on existing local roads. The development of a rationalised arterial road system within the site, in conjunction with transport planning for the whole of the north-west corridor, will assist achieving this objective.

Advantages offered to current residents of the area by the proximity of the proposed development include a closer and more convenient location to schools, shops, bus services and a range of other community and recreational facilities.

6.0 ENVIRONMENTAL MANAGEMENT

The environmental impacts that may result from the implementation of this proposal have been identified in Section 5.0. This section summarises and describes the environmental management initiatives which are proposed to mitigate these impacts.

The present proposal is for rezoning rather than for subdivision. Additionally, the present proponents will not be the proponent for all subsequent development work, or the owner of future development lots. Therefore, achievement of the environmental management objectives will require the cooperation of future landowners and the City of Wanneroo, who will be the managers of much of the site following development.

6.1 Detailed Design

Environmental management objectives will be accommodated by subdivision design to the greatest practical extent. Specific elements which will be addressed include the following:

6.1 1 Preservation and Management of Vegetation

Maximum areas of existing native vegetation will be retained within public open space, schools and community centres, commercial areas, and in accordance with Local Authority and Ministry of Education policy. The purpose of this objective is to:

- preserve as much of the existing vegetation as possible and optimise the aesthetic values of the site following development,
- provide a passive method for noise attenuation from sources such as roads and motor sport venues, and
- protect the groundwater resource from adverse change.

Areas designated as passive public open space present the greatest opportunity to preserve coherent reserves representative of the existing vegetation types. The preservation of tall canopy species and associated understorey will also receive consideration with large building lots including schools and community centres, in which the area of cleared land required for

building will be proportionally smaller than within smaller lots. On residential lots, selected significant trees and stands of vegetation will be marked prior to clearing and will be retained where practicable.

The retention of areas of native vegetation will assist to preserve limited habitat for seasonally transient bird species that follow Jarrah-*Banksia* woodland flowering patterns.

Specific allowance is made within the Development Plan for the conservation of an area of approximately 4 hectares comprising the seasonal dampland adjacent to Lee-Steere Drive within close proximity to the site's eastern boundary. The location of this reserve will serve the multiple role of protection of the honey possum mythological site, habitat protection, preserve aesthetic values and act as a buffer to roadway noise.

Revegetation and landscaping will also be incorporated within developed areas, using suitable native species and will be assisted by the recovery and re-use of topsoil from earthworks programs. The revegetation program will also be incorporated as required in public open space areas and in the grounds of commercial and community facility sites, in line with Government-sponsored tree planting incentive schemes and in accordance with the requirements of the City of Wanneroo.

6.1.2 Design for Water Conservation

Recent design principles for water conservation within urban areas, reported by the Western Australian Water Resources Council (WAWRC, 1990), will be incorporated to the greatest practical extent allowable by the City of Wanneroo during detailed engineering design. Stormwater runoff from roads and other hard surfaces will be directed to drainage soakage basins where water table recharge will occur. Retention of maximised areas of native vegetation, as discussed in Section 6.1.1, will assist greatly in this regard due to the low water requirements of the indigenous species.

6.1.3 Stormwater Management

The design of stormwater handling and disposal will be developed in accordance with current regulatory design specifications. All stormwater will be disposed of on-site using contemporary design criteria. The need for soil amendment within stormwater infiltration basins as a groundwater quality protection measure, will be reviewed in conjunction with the relevant authorities.

Incorporation of revegetation using indigenous species within infiltration areas will also be incorporated where practical.

6.1.4 Groundwater Management

Groundwater abstraction within the project area is the responsibility of the Water Authority, and if proposed will be carried out in accordance with their requirements. The predicted rise of the water table may allow the Water Authority greater flexibility in this regard.

6.1.5 Cultural Reserves

The protection of the Aboriginal mythological honey possum site in a depression within close proximity to Lee-Steere Drive will be achieved by the retention of approximately 4 hectares of land as public open space and the retention of all native vegetation within this area, subject to the requirements of the City of Wanneroo.

6.2 Construction Phase

6.2.1 Noise and Dust Control

Construction will entail extensive site works to establish roads and services such as sewerage and water supply pipelines. Initial site work will involve the use of heavy machinery for clearing prior to construction.

Recognising the friability[3] of the soils and the extent of vegetation to be cleared, the potential for excessive noise and dust during site development will be carefully managed.

The generation of dust and the noise levels by heavy equipment will be regulated to minimise the impact on the surrounding community. The operation of heavy equipment will be restricted to daylight hours and all vehicles will be fitted with noise suppressing devices and comply with standard vehicle emission and noise regulations.

Dust levels will be monitored to ensure compliance with the EPA's "Guidelines for Assessment

[3] Friability - crumbly characteristics

and Control of Dust and Windborne Material for Land Development Sites". The guidelines provide a procedure by which to prevent and/or suppress excessive dust volumes leaving the site during and after the construction of the works.

Dust control methods will include:

- Roads that serve as preparatory vehicle access ways will be watered during operation.
- Topsoil will be replaced on disturbed areas as soon as practically possible.
- Disturbed areas will be stabilised in the event that nuisance conditions arise.
- In the vegetated areas of Lots 1 and 2, Flynn Drive, a buffer strip of vegetation will be maintained as far as practical around the perimeter of the site during construction to act as a dust and noise suppressant.

Measures to minimise smoke nuisance will include:

- The disposal of cleared vegetation by methods other than burning will be utilised to the greatest practical extent to ensure that a minimum amount of open burning is carried out.
- Whenever possible, any burning that must be carried out will be conducted during favourable meteorological conditions, when the wind direction will direct smoke away from residential areas.
- Non vegetative material will not be burnt or used to promote burning.

The existing EPA limit for the maximum allowable level of dust concentration in the atmosphere is 1000 $\mu g/m^3$ measured at the boundary of the site. If this level is exceeded, further on-site dust controls must be implemented.

6.2.2 Fuel Management

Protection of the groundwater resource from uncontrolled fuel spills will be achieved by sealing the area under the fuel storage vessel with a continuous, double-thickness polythene sheet

covered with soil of sufficient volume to contain any spill occurring during refuelling. In the unlikely event that spillage of fuel occurs outside of the refuelling area (eg. from equipment fuel tank rupture), the contaminated soil will be immediately removed for disposal in an approved manner.

6.2.3 Heavy Vehicle Traffic Management

Heavy vehicle movements during site development will be restricted to daylight hours, Monday to Saturday. Trucking activity will be restricted to the major roads (eg. Wanneroo, Pinjar, Clarkson and Flynn Drive) and will avoid the smaller local roads where possible.

6.2.4 Dieback Protection

Eradication of dieback is virtually impossible once the fungus is well established, therefore every effort must be made to protect disease free areas from initial infestation.

Two site surveys found no evidence of dieback, and accordingly a priority management requirement is to avoid the introduction of the fungus to the site during site development. Therefore, it will be a management priority to ensure that infected soil is not imported to the site from infected areas. Additionally, if the presence of dieback is indicated at any time, a detailed survey will be undertaken and a hygiene strategy formulated and implemented.

6.2.5 Public Safety

In the interests of public safety, access to the development site during the construction phase will be restricted and appropriate warning signs will be erected.

6.3 Post-Construction Phase

6.3.1 Management of Public Open Space

Areas of public open space within the development area will assume a number of functional roles, each requiring specific management strategies to cater for the differing end uses and users. These functions and the appropriate management principles will be implemented to the greatest practical degree, subject to the requirements of the City of Wanneroo. These include the following:

(i) Recreation Reserves

Traditional turfgrass playing fields for team sports will be provided within the development by the Local Authority.

Guidelines for the management of turf areas have recently been prepared by the Water Authority (1990), which aim to protect the groundwater resource from nutrient contamination, encourage the conservation of available water through judicious watering regimes, and to lower maintenance costs for turf managers, usually the Local Authorities.

The construction, management and ongoing maintenance of the reserves for active and passive recreation will be the responsibility of the Local Authority, which will be requested to incorporate these guidelines into operational procedures, to the greatest practical extent.

(ii) Habitat Reserves

The retention of native vegetation within those areas where this can be practically achieved will provide areas for passive recreation and assist in the retention of habitat areas for native animals.

The future manager of these reserves will be advised of the desired management strategies for these areas, which will include:

- control of weeds
- control of access
- control of fire, and
- control of feral animals.

(iii) Cultural Reserves

The protection of the Aboriginal mythological honey possum site in a seasonally wet depression within close proximity to Lee-Steere Drive will involve the retention of approximately 4 hectares of land as open space. To protect the vegetation within the reserve from degradation, the area should be fenced to allow only pedestrian access and provided with walk trails to assist minimisation of understorey trampling. Interpretive signs to explain the cultural significance of the site to the general community may be desirable.

7.0 CONCLUSIONS

7.1 Benefits

The Urban Expansion Policy Statement for the Perth Metropolitan Region (DPUD, 1990c) identified the land which is the subject of this submission as being appropriate for urban development. Independent studies confirm that the land is readily serviceable and, under the control of three major developer owners, can be immediately developed to provide land for 8,000 - 9,000 households, to assist the Government in reaching its housing target.

The Urban Expansion Policy indicates a desire for the urban "Corridor" on the eastern side of Wanneroo Road, to extend northwards from the Wanneroo townsite. The multiplicity of ownerships, the relatively small size of most of the landholdings in that remaining area, and the opposition already expressed by many of those land owners, suggests that this course of action will be extremely difficult or even impossible to achieve effectively in the immediate future or the short to medium term. Without positive Government intervention, the only subdivision likely to occur in this area would be on a piecemeal and ad hoc basis, which would be totally uneconomic for the majority of subdividers involved, for the Government and the community at large, and without regional planning merit.

Conversely, the subject land provides a ready opportunity to commence early development and to establish a substantial community on the eastern side of Wanneroo Road, which will generally be self sufficient in terms of community and retail infrastructure needs. As detailed previously, the land uses incorporated within the Development Plan include a High School, a District Centre together with a number of Neighbourhood Shopping Centres, six Primary Schools and other community facilities necessary to create an immediate sense of community. The Urban Expansion Policy Statement recognises the suitability of the land and lists it as category 'A', ie land relatively unconstrained and suitable for urban development.

This proposal therefore offers the opportunity to achieve a highly efficient utilisation of the land for urban purposes.

7.2 Environmental Impacts

The principal environmental impact that will result from establishment of urban development in the project area will be the removal of native vegetation and habitat that presently exists within the northern portion of the site.

There will also be impacts on local superficial groundwater, principally an anticipated rise in the water table. The local shallow aquifer has exhibited falling water table levels over the past 30 years, resulting in lowering of water levels in local wetlands. It is anticipated that the development will result in the water table rising to more than offset the probable decline from future groundwater abstraction, therefore partially restoring some of the falls that have occurred since settlement of the area.

As the anticipated water table rise will occur over an extended period of time, the wetlands which are effected will have gradually increasing water levels. This aspect of the development is considered to be of probable benefit, recognising that water levels have historically fallen. Groundwater quality changes, to the detriment of beneficial uses, are not anticipated.

The establishment of urban land uses within the project site will change the present semi rural/rural landscape and aesthetic character of the locality, however, the local presence of fixed landscape elements including Neerabup National Park, the proposed Yellagonga Regional Park, Lake Adams and State Forest 65 will significantly mitigate this change.

7.3 Environmental Management

Management to mitigate the anticipated environmental impacts will need to include the initiatives listed below;

- Allowance for retention of the maximum practical area of native vegetation within suitable locations, during detailed subdivision and development planning. The cooperation of the City of Wanneroo and future landowners will be desirable to achieve this objective.

- The incorporation to the greatest practical degree of water conservation and nutrient management measures within future detailed planning and landscape design for the

development area. The cooperation of the City of Wanneroo and future landowners will also be necessary for this objective to be achieved.

- Management of construction phase operations to prevent noise, dust, smoke and heavy vehicle traffic nuisance, dieback control if necessary, and handling of fuels in accordance with Water Authority specifications to prevent groundwater contamination.

- Management of preserved natural vegetation following development to control access and minimise the effects of trampling, weeds, fire and feral animals.

- Management of nutrients and water usage within active recreation areas to protect groundwater quality and minimise water consumption.

7.4 Conclusion

The implementation of this proposal will provide benefits to the community through the achievement of strategic planning goals for housing and community infrastructure in the north-west corridor. Localised changes to the present rural character of the area will occur due to this proposal. However, the north-west corridor structure plan recognises the importance of rural landscapes and land uses, and has accommodated substantial areas of the region for this purpose.

The environmental cost of these community benefits will be the removal of a tract of native vegetation in good biological condition. The vegetation complex type which will be removed (Karrakatta Central and South) is represented in secure conservation reserves including seventeen examples in fifteen metropolitan System Six conservation reserves, and an additional three country System Six reserves. The conservation reserves total approximately 5,500 ha in area, however this does not imply that this total area is solely Karrakatta Central and South vegetation..

Additional to the System Six reserves, there is in excess of 20,000 ha of proposed CALM conservation reserve in the Wanneroo District whose principal vegetation type is *Banksia* and associated woodlands.

The cooperation of future landowners and developers of allotments created by the proposal will be required to effectively achieve management objectives for those vegetation reserves within the site which can be retained.

Urbanisation within the proposed site will contribute, together with other urban growth proposals, towards an anticipated increase in groundwater levels in the shallow aquifer, returning to levels which are believed to be more consistent with the period prior to intensive settlement of the area. This is expected to assist the maintenance of local wetland ecosystems.

The potential impacts of the construction phase of the proposal can be maintained to within acceptable limits by the adoption of the specified environmental management procedures.

8.0 COMMITMENTS

The proponents undertake to comply with each of the commitments which are made in this document to the satisfaction of the relevant statutory authority. It is to be noted that the present proposal is for rezoning rather than for subdivision and that the present proponents will not be the owners of future development lots created by the Development Plan, or the proponents for all subsequent development work.

This requires accommodation and acknowledgment by the relevant regulatory authorities in the course of processing this proposal. This section of the report reiterates and enumerates individual commitments which have been made within this Public Environmental Review document.

8.1 Detailed Design

1. The proponent will accommodate environmental management objectives listed below in the following commitments within the forthcoming subdivision design to the greatest practical extent, to the satisfaction of the Department of Planning and Urban Development and the City of Wanneroo.

2. The proponent will formulate the subdivision design to maximise the retention of existing native vegetation as far as is practical within public open space, schools, community centres and commercial areas, to the satisfaction of the Department of Planning and Urban Development and the City of Wanneroo.

3. The proponent will incorporate to the greatest practical extent, recent design principles for water conservation reported by the Western Australian Water Resources Council (WAWRC, 1990), to the satisfaction of the Water Authority and the City of Wanneroo.

4. The proponent will design stormwater handling and disposal facilities during the detailed engineering design phase of the project, in accordance with current regulatory design specifications and to the satisfaction of the City of Wanneroo. All stormwater will be disposed of on-site using current design approaches.

5. Should groundwater abstraction within the project area be proposed by the proponent, abstraction will be designed and carried out to the satisfaction of the Water Authority.

6. The proponent will accommodate the protection of the Aboriginal mythological honey possum site by the retention of approximately 4 ha of land as public open space, and the retention of all native vegetation within this area, to the satisfaction of the Department of Planning and Urban Development and the City of Wanneroo.

8.2 Construction Phase

The proponent will achieve effective noise and dust control during the construction phase of the project, to the satisfaction of the Environmental Protection Authority, as follows:

7. The operation of heavy machinery will be restricted to between 0630 and 1830 hours or in accordance with Local Authority regulations and all vehicles will be fitted with noise suppressing devices which will comply with standard vehicle emission and noise regulations.

8. Compliance with appropriate EPA Dust Guidelines for the development sites will be ensured by the adoption of appropriate site works procedures.

9. Preparatory vehicle access roads will be watered during operation.

10. Disturbed areas will be covered with top soil, and in the event that nuisance conditions arise, the areas will be stabilised.

The proponent will minimise smoke nuisance during the construction phase of the project, to the satisfaction of the City of Wanneroo, as follows:

11. The disposal of cleared vegetation by methods other than burning will be utilised to the greatest practical extent.

12. Wherever possible, any burning that must be carried out will be conducted under favourable meteorological conditions.

13. Non-vegetative material will not be burnt or used to promote burning.

The proponent will carry out fuel management during the construction phase of the project, to the satisfaction of the Water Authority, as follows:

14. Any fuel storage vessel which is utilized on-site will be located within an area which is sealed with a continuous double-thickness polythene sheet covered with soil, of sufficient volume to contain any spill which may occur during refuelling.

15. In the event that a fuel spillage occurs outside the compound, the contaminated soil will be immediately removed for disposal in an approved manner.

The proponent will manage heavy vehicle traffic during the construction phase of the project, to the satisfaction of the City of Wanneroo, as follows:

16. Heavy vehicle movements will be restricted to between 0630 and 1830 hours or in accordance with Local Authority regulations, Monday to Saturday. Vehicles will be restricted to the major roads where possible.

The proponent will accommodate dieback protection procedures during the construction phase of the project, to the satisfaction of the Environmental Protection Authority, as follows:

17. In the event that dieback is detected, a detailed dieback hygiene strategy will be defined to limit the risk of spread within or beyond the site. In the event that fill is required, it will not be imported from dieback infected areas.

18. Public safety will be recognised by the restriction of access to the development site during the construction phase and the erection of appropriate warning signs.

19. The proponent will optimise revegetation success by the recovery and re-application of top soil during site preparation works, to the greatest practical extent, to the satisfaction of the City of Wanneroo.

8.3 Post-Construction Phase

20. The proponent will request that following their establishment, the management of grassed areas of public open space (which will be the responsibility of the City of Wanneroo) accommodate guidelines recently prepared by the Water Authority to protect the groundwater from nutrient contamination and to conserve water, to the satisfaction of the Water Authority.

21. In the course of the land transfer process, the proponent will advise the future managers of areas which support or could support native vegetation reserves, of the desirability of retaining natural vegetation and the appropriate management strategies for these areas, to the satisfaction of the City of Wanneroo.

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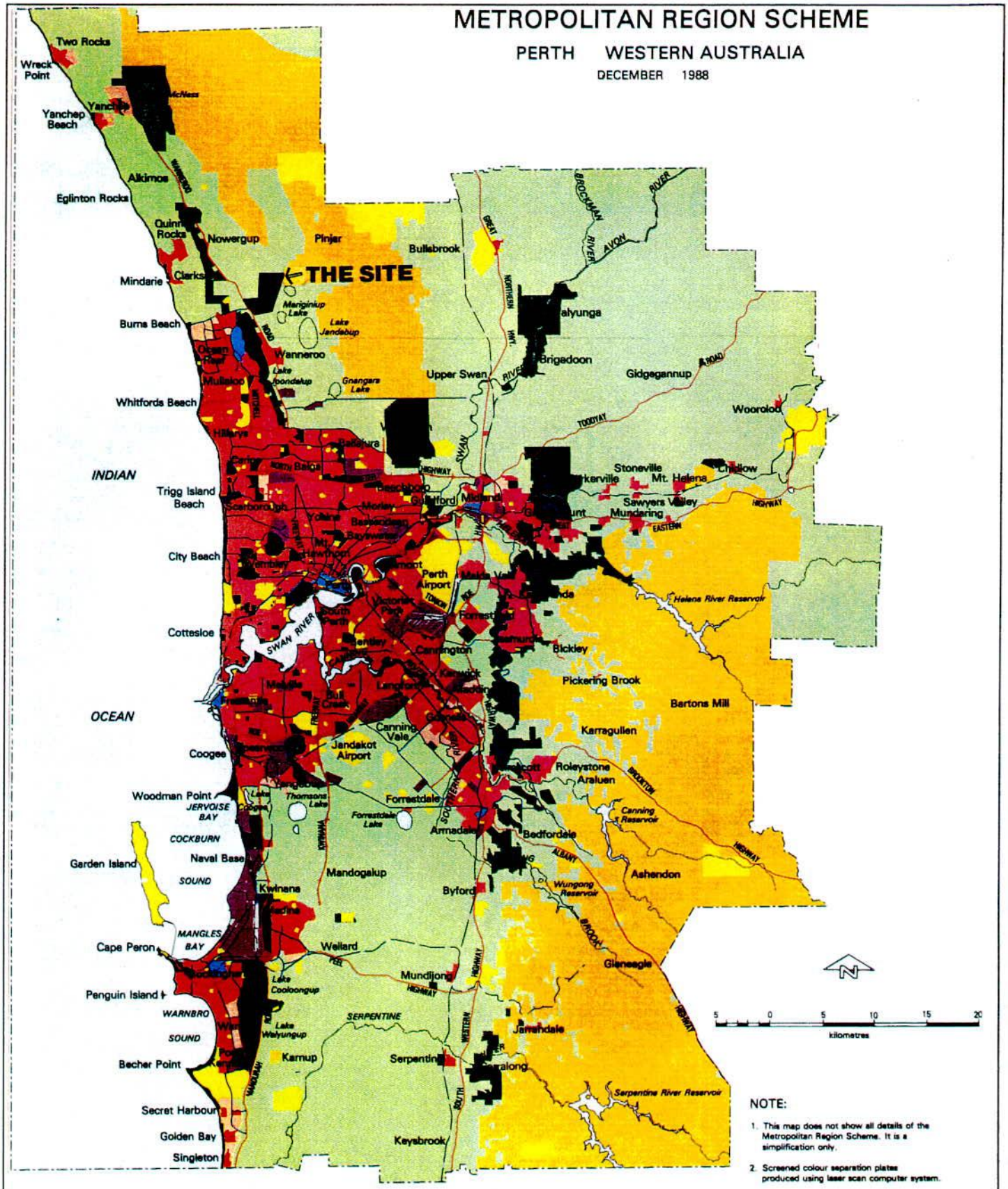
10.0 FIGURES

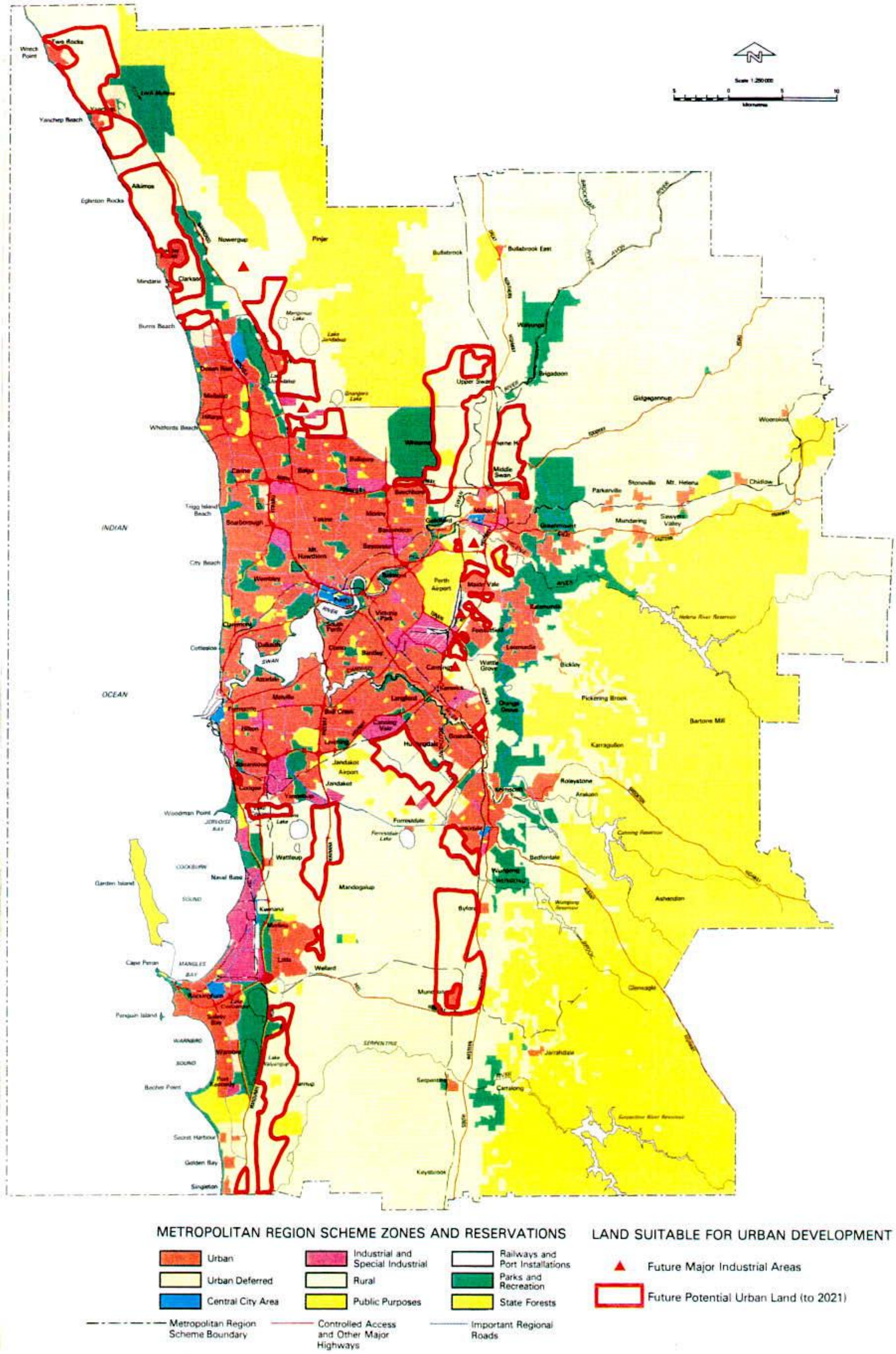


EAST OF JOONDALUP URBAN DEVELOPMENT PROJECT

REGIONAL LOCATION

Figure 1

BOWMAN BISHAW GORHAM

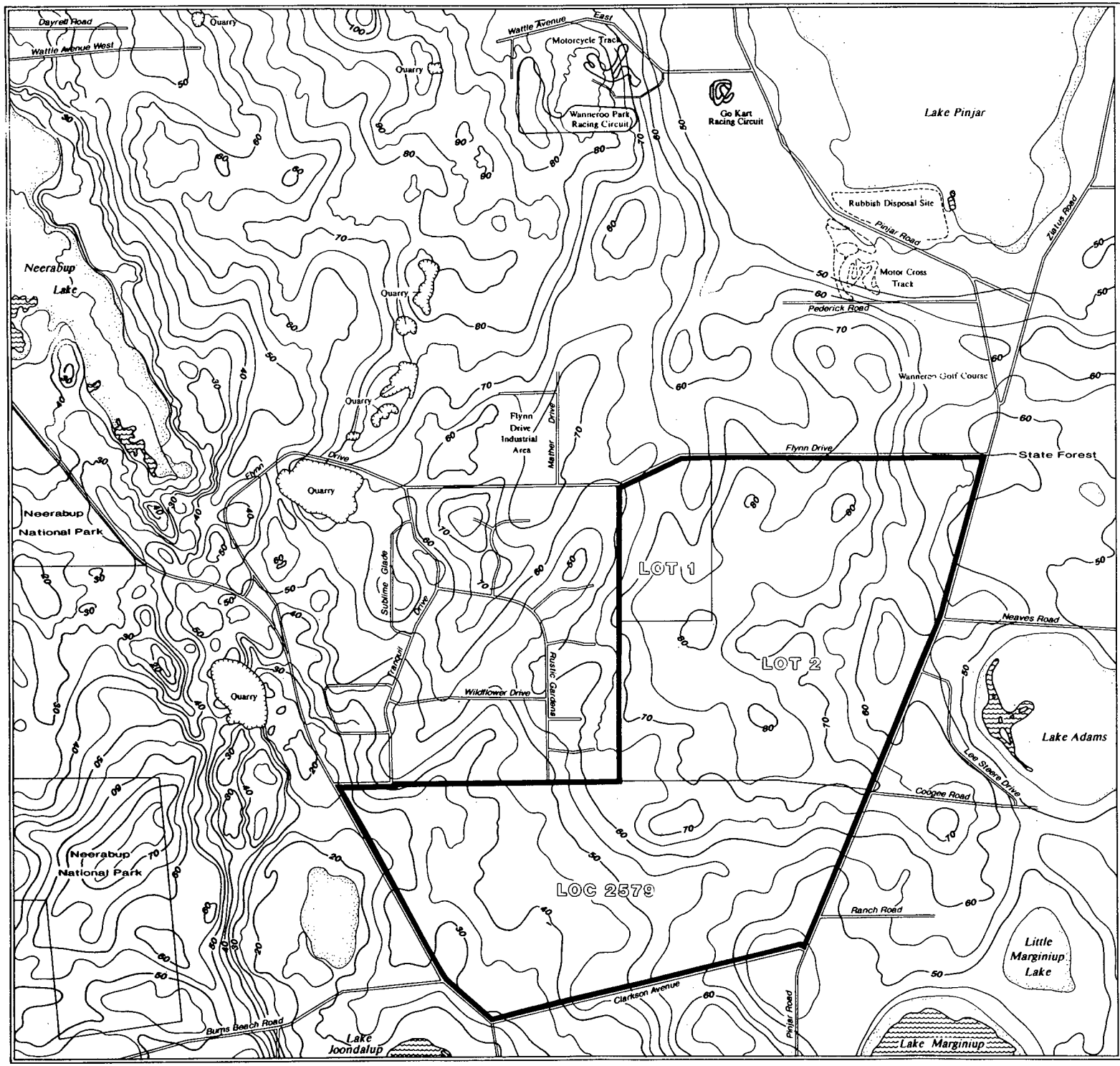


EAST OF JOONDALUP URBAN DEVELOPMENT PROJECT

URBAN EXPANSION AREAS

(after DPUD, 1990d)

Figure 2

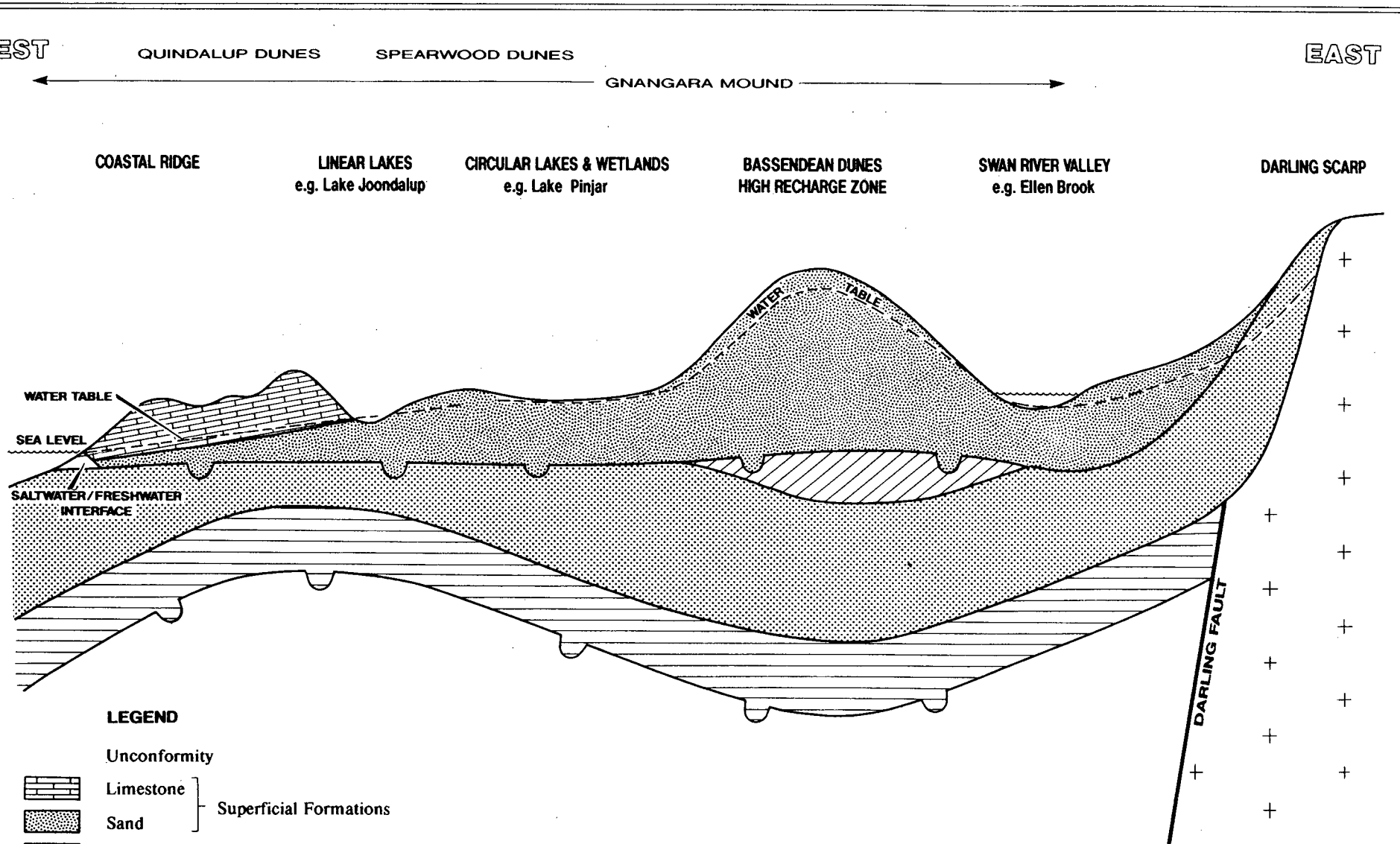


EAST OF JOONDALUP URBAN DEVELOPMENT PROJECT

SITE TOPOGRAPHY

Figure 3

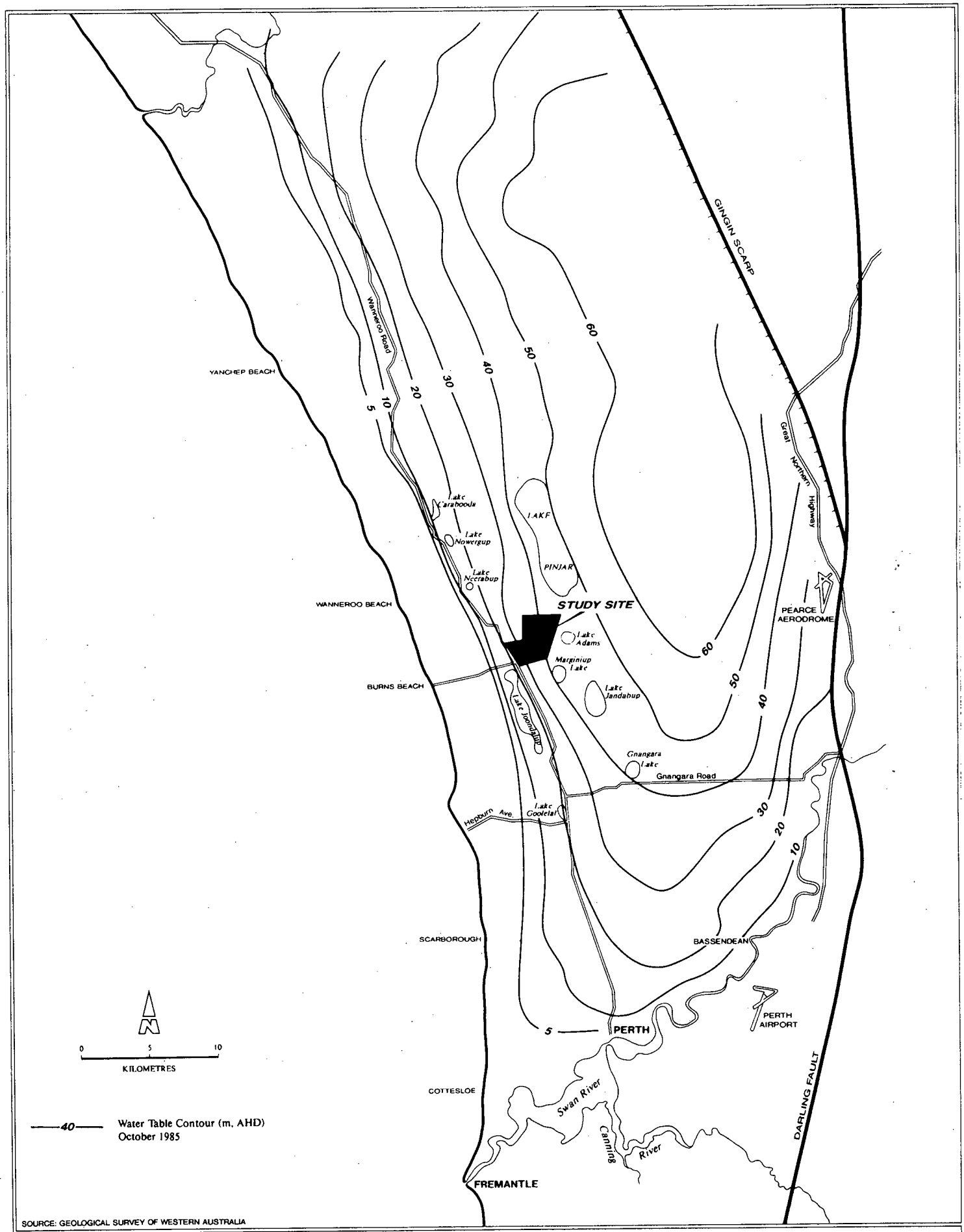
BOWMAN BISHAW GORHAM



GNANGARA MOUND

SCHEMATIC STRATIGRAPHIC CROSS SECTION

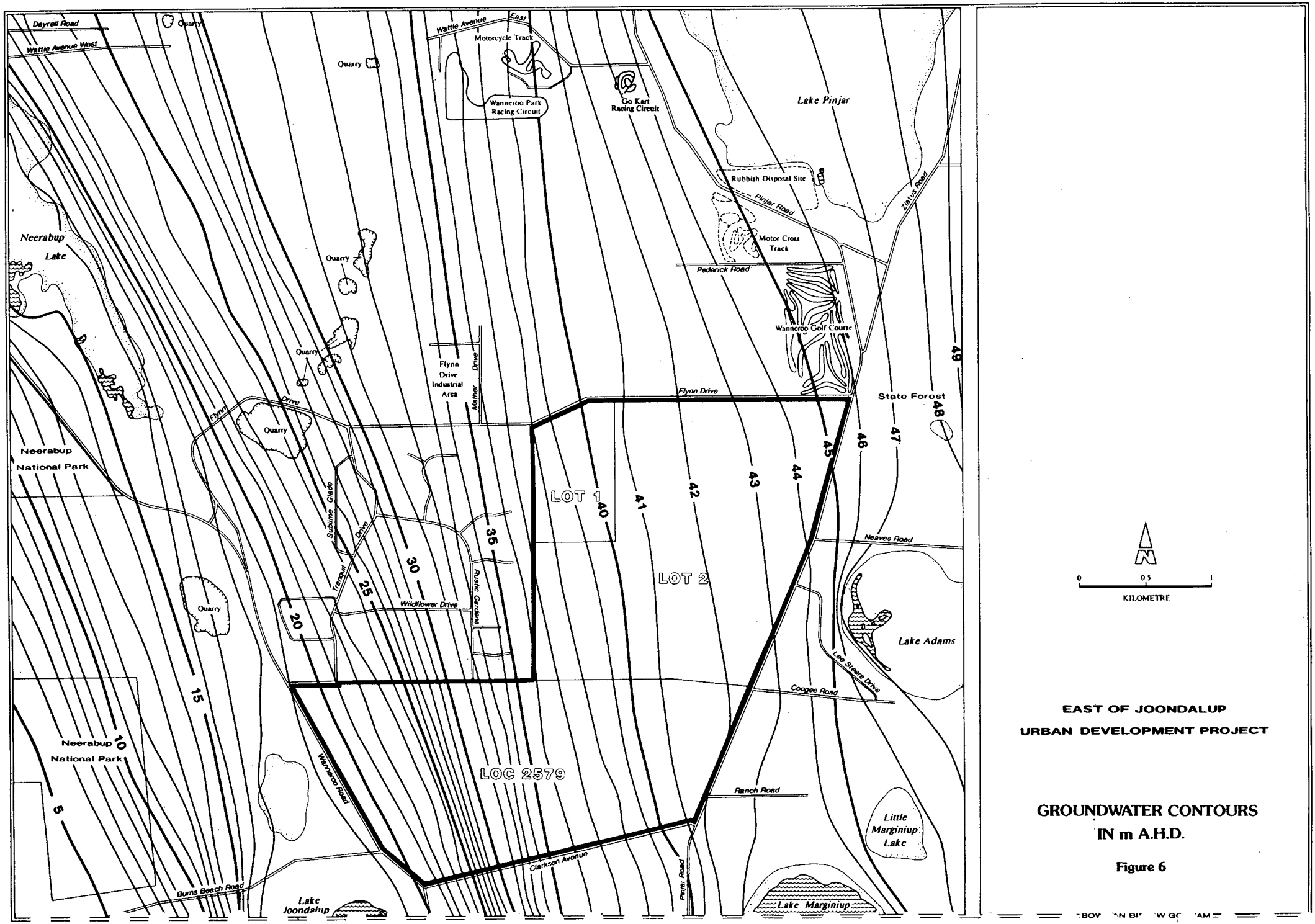
Figure 4



EAST OF JOONDALUP URBAN DEVELOPMENT PROJECT

WATER TABLE CONTOURS - GNANGARA MOUND

Figure 5

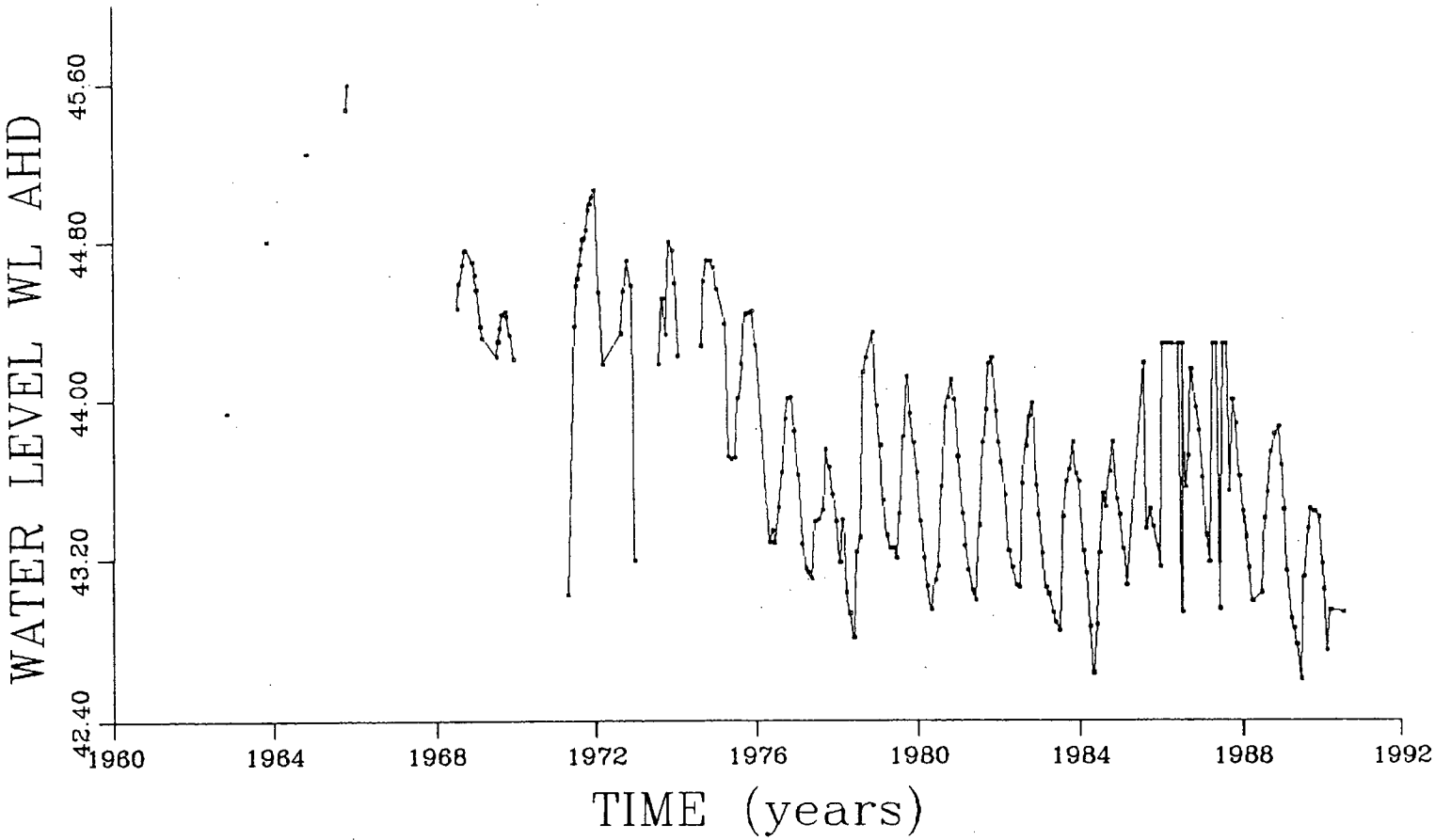


EAST OF JOONDALUP

URBAN DEVELOPMENT PROJECT

GROUNDWATER CONTOURS IN m A.H.D.

Figure 6

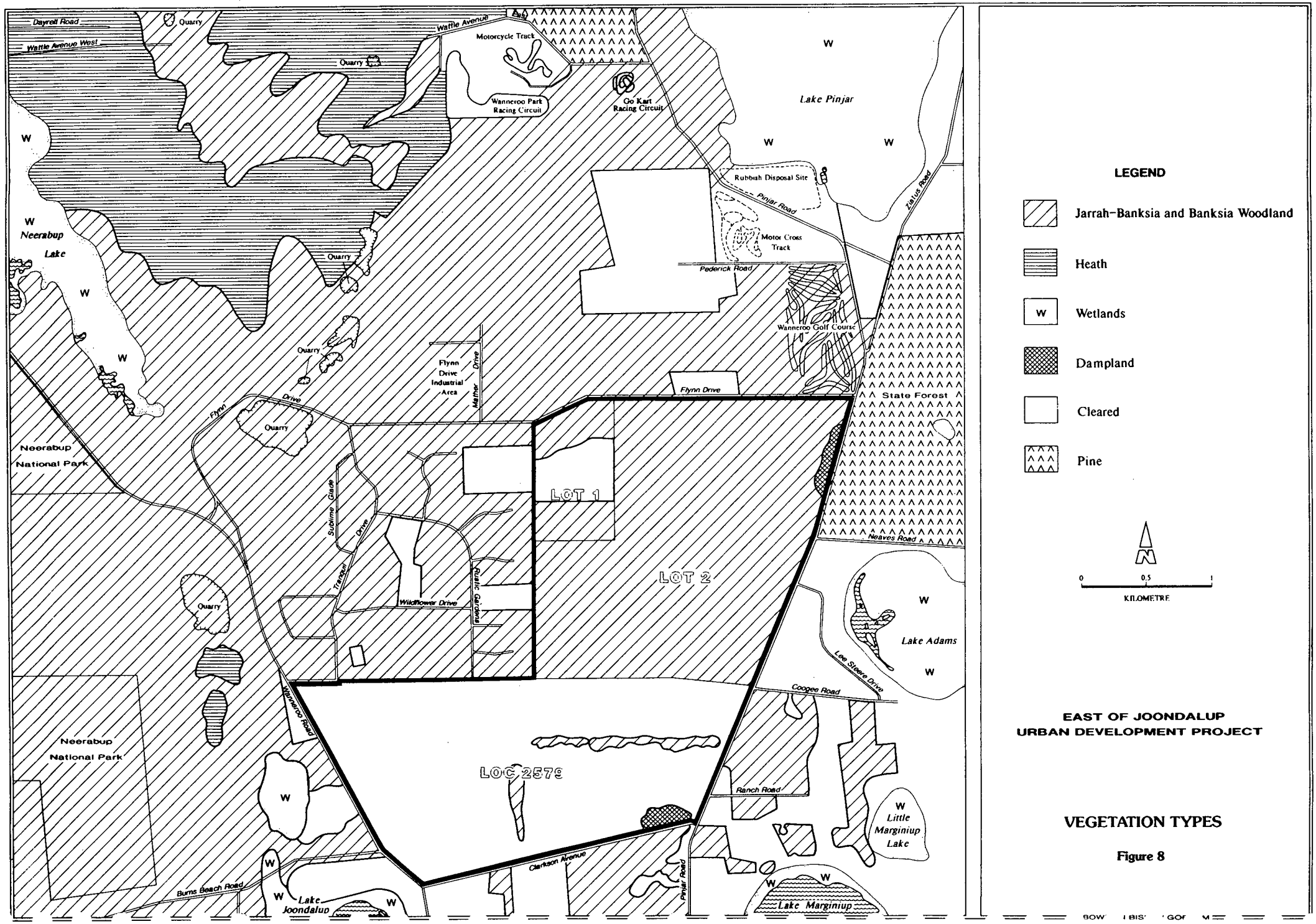


SOURCE: WATER AUTHORITY OF W.A.

EAST OF JOONDALUP URBAN DEVELOPMENT PROJECT

MONITOR BORE HYDROGRAPH OF LAKE ADAMS

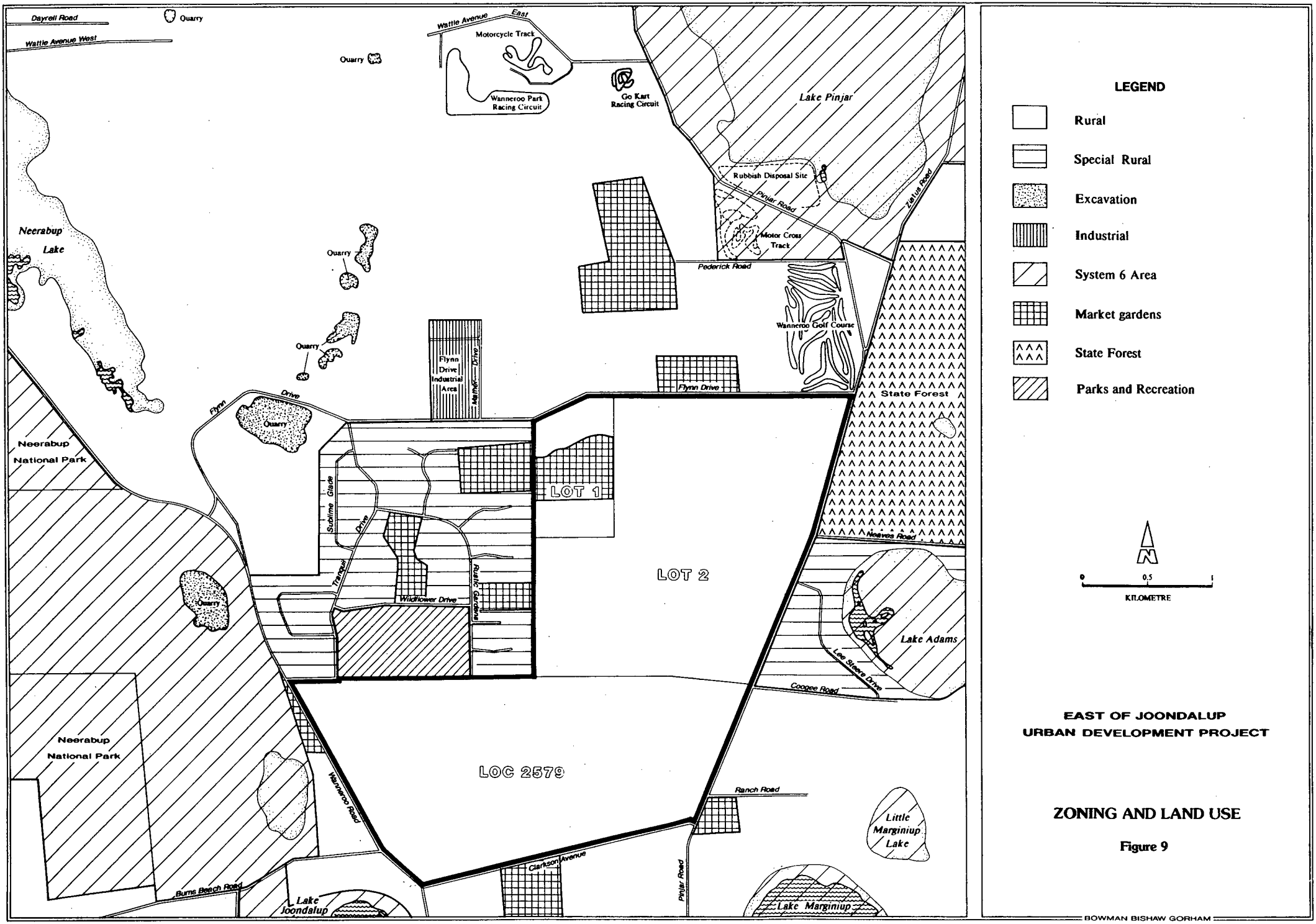
Figure 7

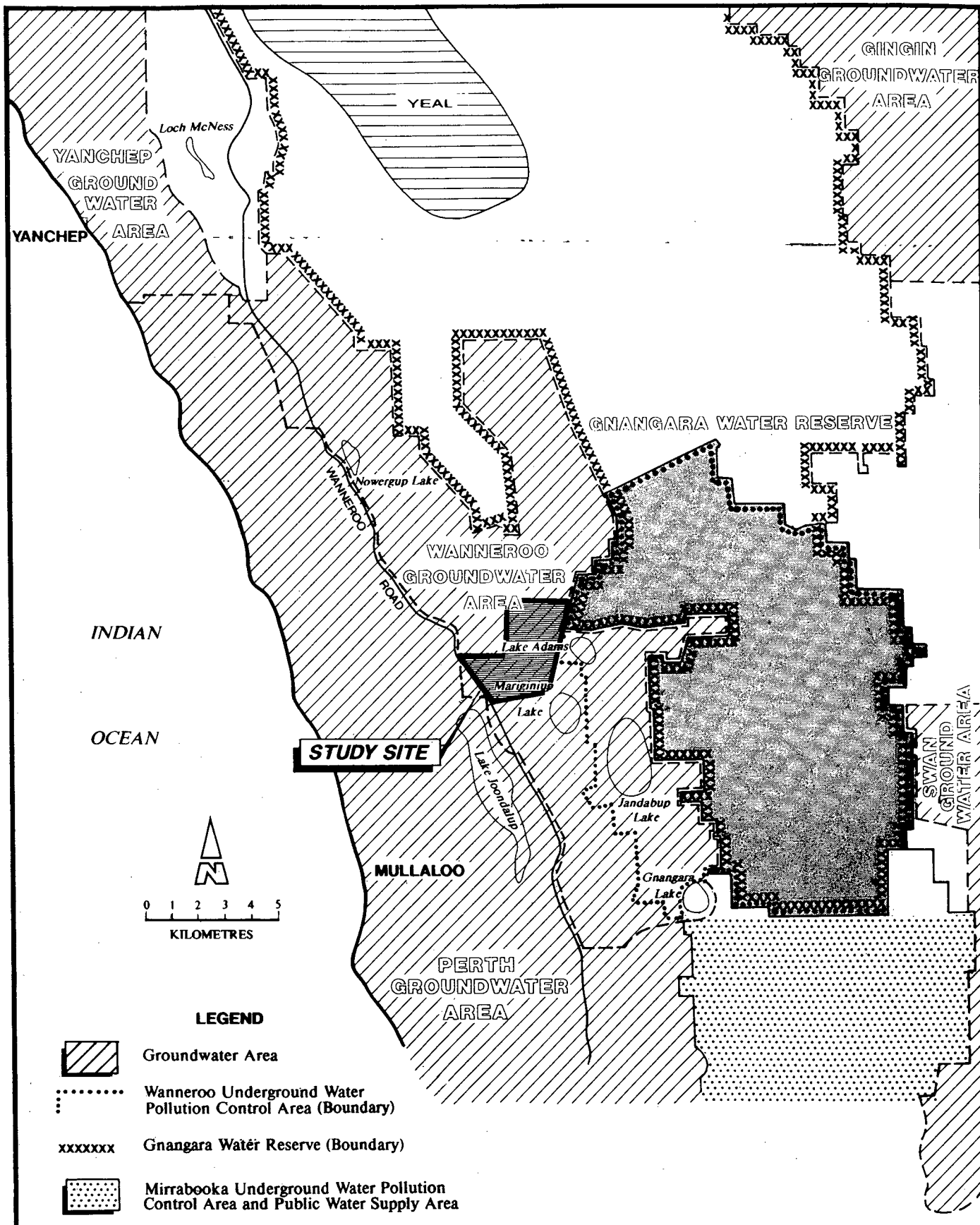


EAST OF JOONDALUP URBAN DEVELOPMENT PROJECT

VEGETATION TYPES

Figure 8


Dayrell Road
Wattle Avenue West
Wattle Avenue East
Quarry
Motorcycle Track
Wanneroo Park Racing Circuit
Go Kart Racing Circuit
Lake Pinjar
Rubbish Disposal Site
Pinjar Road
Zeltus Road
Motor Cross Track
Pederick Road
Neerabup Lake
Wanneroo Golf Course
Flynn Drive Industrial Area
Flynn Drive
State Forest
Neerabup National Park
LOT 1
LOT 2
LOC 2579
Sublime Glade
Tranquil Drive
Rural Gardens
Wildflower Drive
Neaves Road
Lake Adams
Lee Steere Drive
Coogee Road
Wanneroo Road
Ranch Road
Clarkson Avenue
Little Marginiup Lake
Lake Marginiup
Burns Beach Road
Lake Joondalup
LEGEND
Rural
Special Rural
Excavation
Industrial
System 6 Area
Market gardens
State Forest
Parks and Recreation
0.5
1
KILOMETRE
EAST OF JOONDALUP
URBAN DEVELOPMENT PROJECT
ZONING AND LAND USE
Figure 9
BOWMAN BISHAW GORHAM

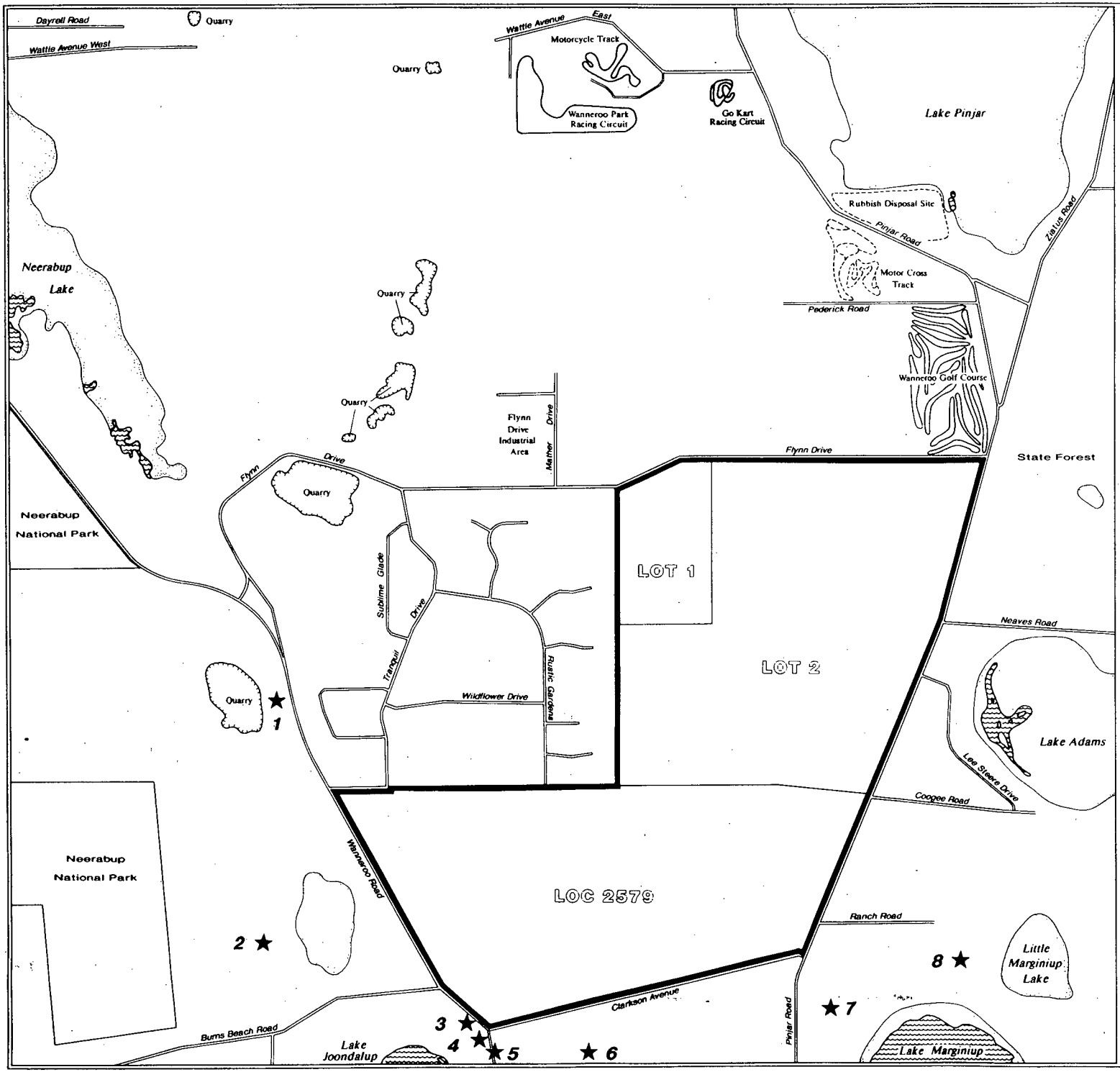


EAST OF JOONDALUP URBAN DEVELOPMENT PROJECT

GROUNDWATER MANAGEMENT AREAS

Figure 10

BOWMAN BISHAW GORHAM



LEGEND

1 Lime Kiln
2 Scarp working
3 Ashby House
4 Chitty House
5 Chitty House
6 Ashby House
7 Delamare House
8 Lenzo House

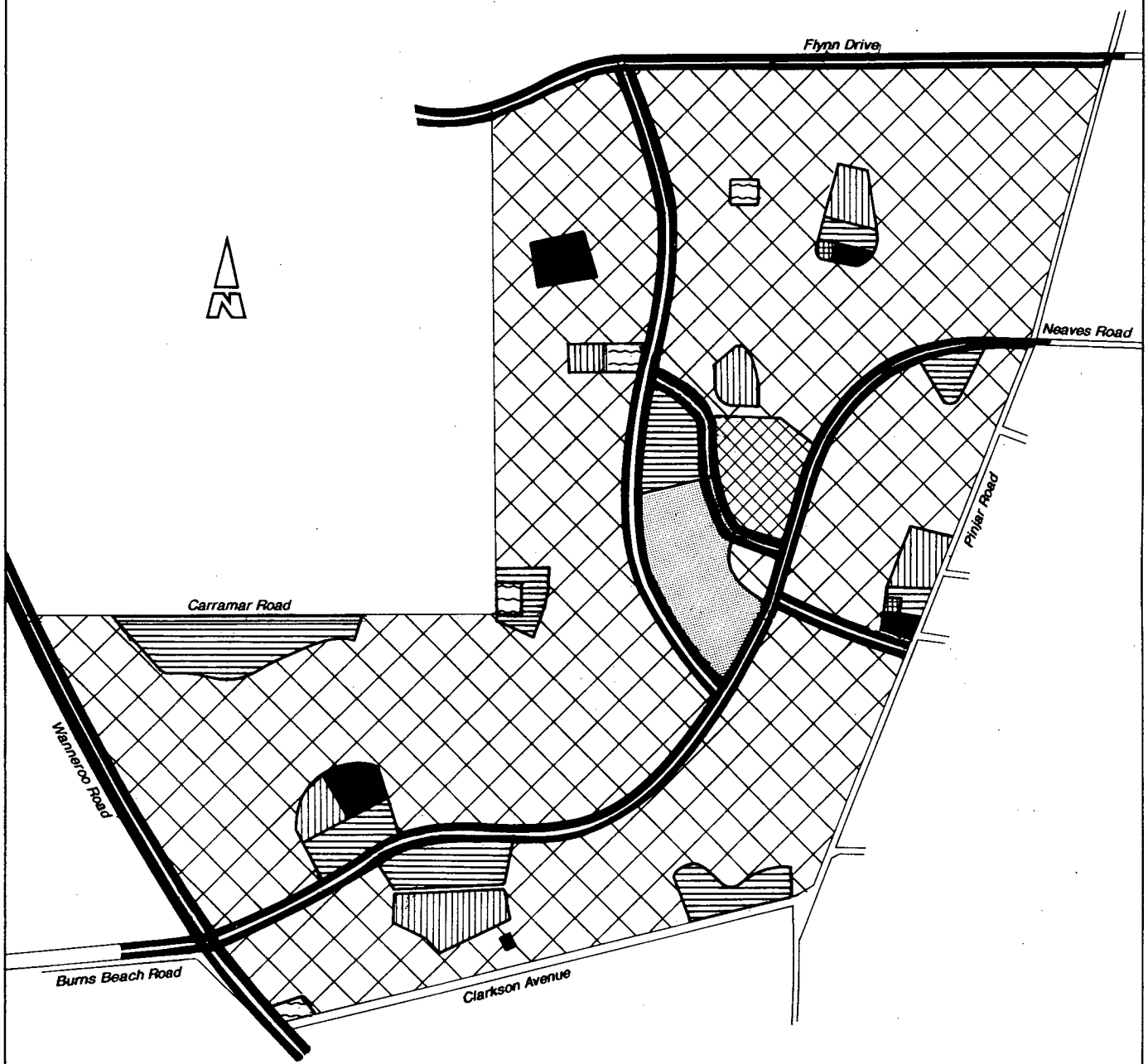
0 0.5 1
KILOMETRE

EAST OF JOONDALUP URBAN DEVELOPMENT PROJECT

LOCATION OF HISTORICAL SITES

Figure 11

BOWMAN BISHAW GORHAM

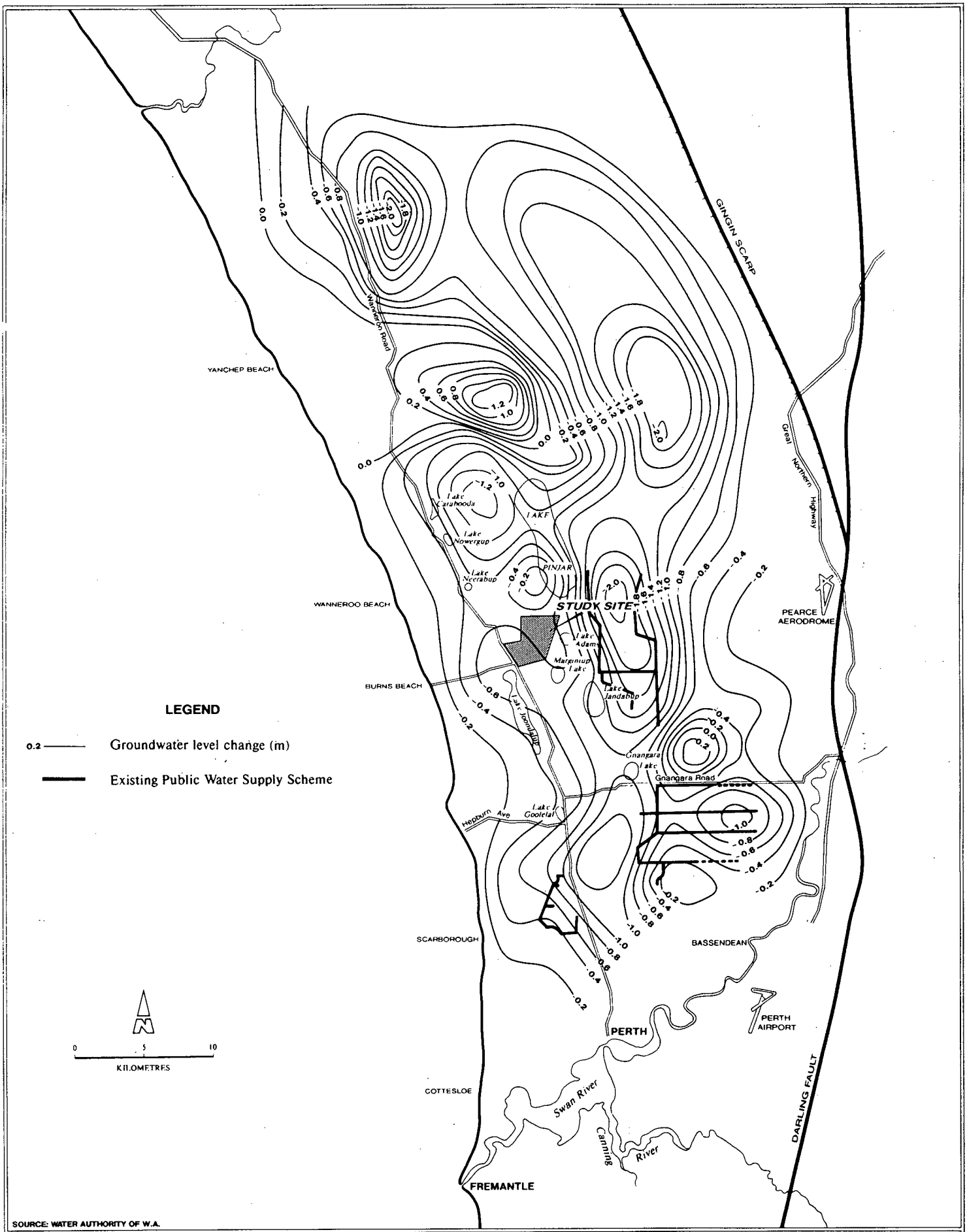


- Residential
- District Centre
- Neighbourhood Centre
- High School
- Primary School
- Community Purposes
- Public Open Space
- Public Utility

EAST OF JOONDALUP
URBAN DEVELOPMENT PROJECT

DEVELOPMENT CONCEPT

Figure 12

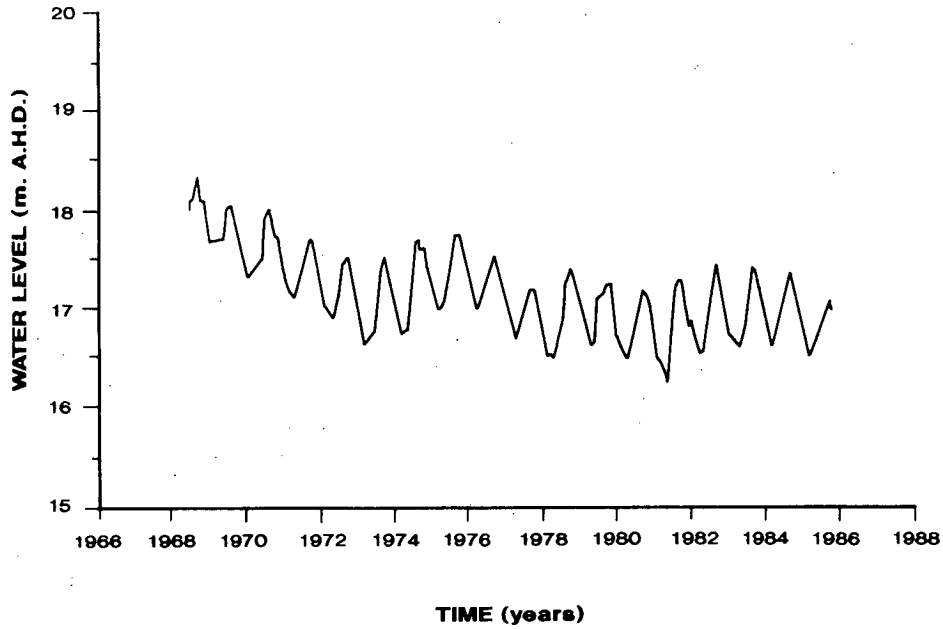


SOURCE: WATER AUTHORITY OF W.A.

EAST OF JOONDALUP URBAN DEVELOPMENT PROJECT

WATER LEVEL CHANGES FROM 1976 to 1985

Figure 13

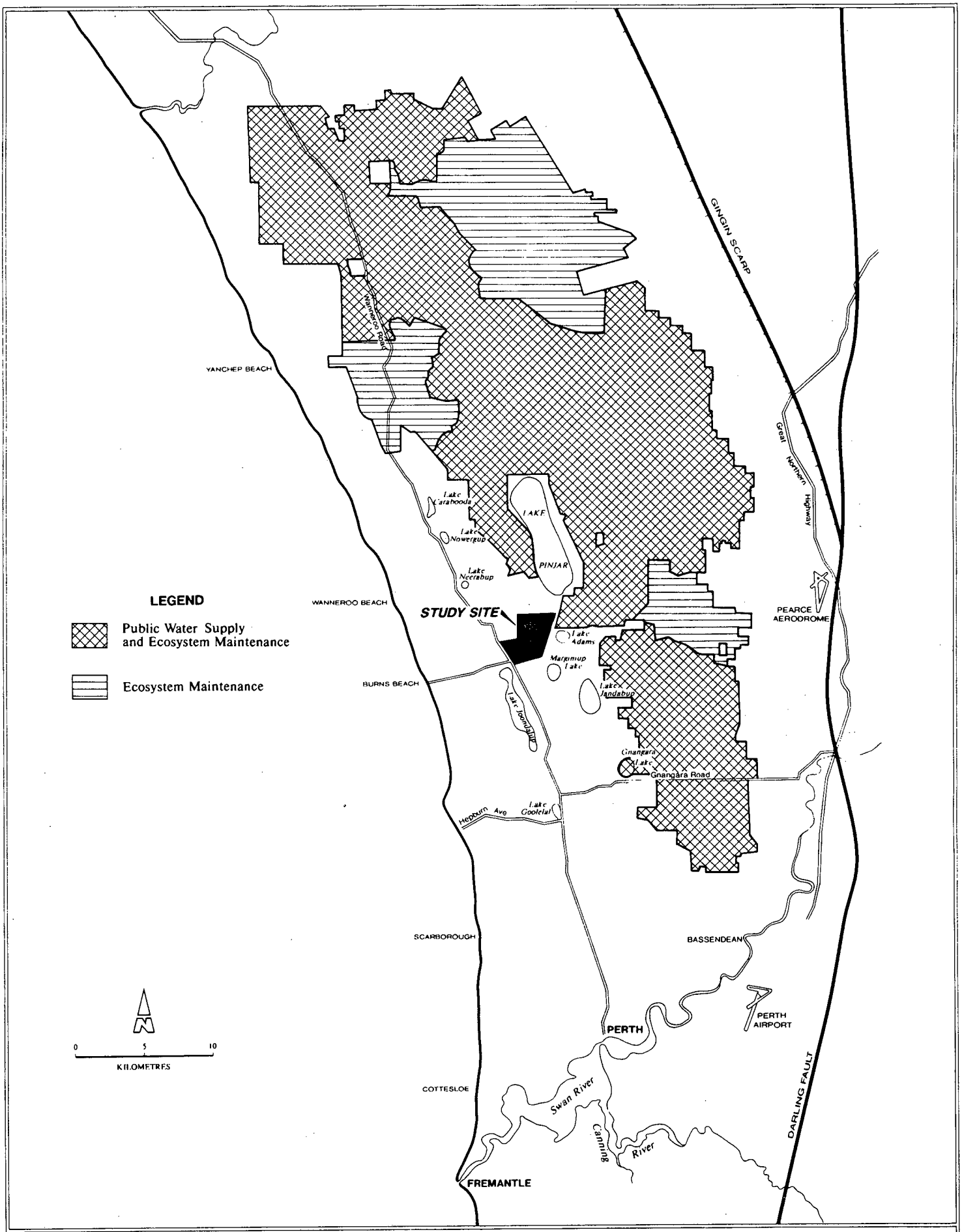


SOURCE: WATER AUTHORITY OF W.A.)

EAST OF JOONDALUP URBAN DEVELOPMENT PROJECT

WATER LEVEL TRENDS IN LAKE JOONDALUP

Figure 14



EAST OF JOONDALUP URBAN DEVELOPMENT PROJECT

BENEFICIAL USES OF GROUNDWATER RESOURCE

Figure 15

APPENDICES

APPENDIX A

Water Balance Characteristics and Present Groundwater Quality

APPENDIX A WATER BALANCE CHARACTERISTICS AND PRESENT GROUNDWATER QUALITY

1.0 INTRODUCTION

The establishment of urban land uses within naturally vegetated or cleared agricultural land is often accompanied by changes in the average position of the underlying water table, usually in the form of an overall water table rise. This effect results from the changes to the hydrological balance brought about by the establishment of built structures and impervious surfaces over ground that was previously porous.

Under natural conditions, the position of the water table is controlled by the dynamic equilibrium that exists between the following factors:

- Amount of rainfall
- Evapotranspiration (uptake) by trees and perenial vegetation
- Direct evaporation of moisture from lake surfaces
- Aquifer recharge, which is the nett amount of rainfall that drains from the soil surface to enter the unconfined aquifer, and
- Lateral groundwater movement.

Urban development may change the natural hydrological cycle by one or more of the following factors:

- Removal of trees reducing the proportion of rainfall that is evaporated and evapotranspirated.
- Impervious surfaces reducing the amount of direct evaporation of soil moisture.

- Impervious surfaces collecting rainfall, which is then directed to stormwater infiltration basins which concentrates the recharge process and increases the amount of water which reaches the water table.

- Importation of scheme water, and its application to the land as either irrigation and/or domestic waste water, providing an additional source of recharge.

- Abstraction of groundwater by private bores changing the amount of groundwater in the aquifer (in this case a reduction).

In urban areas within the south-west of the State, rising water table levels have effected water levels in nearby wetlands which are essentially surface expressions of the shallow groundwater, sometimes to their detriment.

It is therefore important to characterise the hydrological cycle of a proposed development site prior to development so that any change which may be brought about by urban development, and possible environmental effects, can be anticipated and accounted for by appropriate management.

This appendix examines the recharge components of the water balance to provide a basis for predicting the impact that urban development will have on local groundwater levels.

The principal emphasis of this part of the report is to examine the recharge that presently occurs within the site, and the amount of groundwater that is lost from the aquifer within the site, principally in relation to groundwater abstraction.

(i) Aquifer Recharge

The average volume of nett aquifer recharge that presently occurs within the site has been calculated from the following data:

- Perth's long-term average rainfall (869 mm).

- Recharge coefficients for *Banksia* woodland of 0.15-0.40 developed by Butcher (1979) and CSIRO (Sharma, pers. comm., Sept 1989).

- Recharge coefficients of 0.44-0.66 of winter rainfall for pasture land developed by CSIRO (Sharma, pers. comm.).

- Recharge estimates for irrigated floricultural land derived from groundwater abstraction and irrigation data presented in Cargeeg *et al.* (1987), CSIRO (1979), and assuming crop evapotranspiration is equivalent to 0.7 x Perth' average monthly pan A evaporation.

- Recharge estimates for residential land developed by McFarlane (1981).

Summation of the nett recharge estimates for each of the sites component areas in terms of land use type leads to an overall estimate within the range 1,538 ML and 3,339 ML.

(ii) Groundwater Abstraction

At the present time, groundwater abstraction within the site is limited to one area, within Lot 1 Flynn Drive, where floricultural activity utilises groundwater for irrigation.

Approximately 20 ha of Lot 1 Flynn Drive is currently under floricultural use. Water consumption for irrigation of flower crops has been estimated to be 12.5ML/ha/annum (Cargeeg *et al.*, 1987), giving an estimated total for groundwater abstraction of 250ML/annum.

Water consumption within the single residence within Lot 1 Flynn Drive, if groundwater is assumed to be the principal supply, is estimated to be 0.4ML/annum based on figures reported by the Metropolitan Water Authority (1985).

Total annual groundwater abstraction within the site is therefore estimated to be 250.4ML/annum.

iii) Conclusion

Based on the above factors it is estimated that nett recharge minus abstraction at the project site is presently between 1,288ML and 3,089 ML/annum.

2.0 GROUNDWATER QUALITY

Urbanisation of land that overlies unconfined groundwater can cause changes to groundwater quality through the infiltration of stormwater that carries traces of fertiliser and other soluble materials to the aquifer. It is therefore necessary to consider the present condition of the groundwater in terms of physico-chemical quality as a basis from which to consider the potential effects of urbanisation.

Groundwater from the Gnangara Mound superficial formations (of which the site's unconfined aquifer is a part) varies in salinity from 130-12,000mg/L total dissolved solids. The lowest salinity groundwater occurs near the crest of the mound which is located some 15km north-east of the site, while the highest salinity groundwater occurs near discharge areas (Water Authority, 1986). Groundwater salinity is also affected by wetlands where the concentration of solutes is increased by evaporation from the wetland's surface water and transpiration by wetland vegetation (Cargeeg *et al.*, 1987).

A study of groundwater movement near Mariginiup Lake, which is located less than one kilometre south west of the site, demonstrated that salinity downgradient of the wetland was significantly higher than upgradient (Hall, 1985).

The salinity of wetland water (and therefore downgradient groundwater) also varies seasonally. The highest salinity occurs during the summer months through concentration of ions when evaporation is high and rainfall low. The lowest salinity occur during winter when evaporation is low and rainfall is high, effectively diluting saline concentrations.

The project site is located downgradient from Lake Adams and is relatively distant from the crest of the Gnangara Mound. Therefore, it can be expected that groundwater underlying the site has relatively high natural salinity.

Contaminant levels within groundwater beneath undeveloped bushland are typically low. However, the presence of the following land uses within, adjacent to, or near to the site suggest that groundwater beneath the site may contain levels of contaminants above natural background concentrations:

- A flower grower located within the northern sector of the site and market gardens located east of the site may contribute to groundwater contamination via fertiliser leaching and leachate recharge to the aquifer.

- A piggery located approximately 1.0km east of the north-east corner of the site has been inferred by Hirschberg (1988) to be a groundwater contamination source.

- The Special Rural area near Lake Adams, located adjacent to the eastern boundary of the site is unsewered. On-site domestic wastewater disposal is a known potential source of nutrient and microbiological groundwater pollution within the Swan Coastal Plain (Whelan and Parker, 1981).

- The management of the Gnangara Pine Plantation to the east of the site involves the use of fertilisers to maintain growth rates therefore leachate to the aquifer may occur.

- The Wanneroo Public Golf Course located adjacent to the north-eastern corner of the site may contribute to groundwater contamination via fertiliser leaching and by on-site domestic wastewater disposal.

There is no directly useful groundwater quality data for the site and the degree to which groundwater quality has been effected by the land uses noted above is difficult to estimate. Nonetheless, it is reasonable to expect that the groundwater beneath the site would have contaminant levels in excess of background quality typical of groundwater that underlies natural bushland.

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APPENDIX B

Landscape Assessment

APPENDIX B LANDSCAPE ASSESSMENT

1.0 INTRODUCTION

The landscape elements that occur within and adjacent to the site and their visual characteristics are described in this appendix.

2.0 REGIONAL LANDSCAPE ELEMENTS

The site is located near the northern periphery of the present extent of intensive urban development within the Wanneroo area. This is reflected in the land uses dominant in the region, and therefore in the visual characteristics of the landscape.

West of the site the physical landscape consists of dune and swale landforms in a parallel sequence, featuring massive sand and limestone ridge formations, extensive linear wetlands and woodland. To the east, the land is flatter and more gently undulating, and includes large circular wetlands and associated seasonally wet flats, together with natural vegetation dominated by *Banksia* woodland.

Changes to the natural physical landscape have occurred from land use development and have created a suite of altered landscape elements.

Visual appreciation of the regional landscape generally occurs during vehicular transit using the principal roads of the area. The region's physical and aesthetic characteristics viewed from the major regional roads are described below.

Wanneroo Road is a principal regional road which passes to the west of the site. The broad landscape elements that comprise the viewscape from Wanneroo Road include the following.

- On the eastern side of Wanneroo road, between the Wanneroo townsite and the site's southern boundary, views from the road are of traditional low-density residential suburban features, grading to larger land allotments under a mix of horticultural uses and vacant land with remnant vegetation to the north. Views are generally short-distance as the land surface is usually sloping upwards away from the road, with vegetation close to the road or within the road reserve producing a screen effect.

- On the western side of this sector of Wanneroo road, the landscape includes views of suburban residential structures at the Wanneroo townsite, horticultural land uses, pine plantations and uncleared land, with occasional long-distance views over Lake Joondalup and further elevated limestone ridge landform which rises from the lake's western shores.

- Adjacent to the site and further north, the landscape on both sides of Wanneroo Road is dominated by natural vegetation. Neerabup National Park is located directly to the west of the road for a distance of some 8 kilometres. The viewscape includes natural vegetation, broad-acre agricultural land use, vacant cleared land and occasional wetlands.

Pinjar Road is an important regional road to the east of the site. Landscape elements which are discernable from Pinjar Road include the following;

- To the south of the site, the viewscape includes gently undulating sand dune terrain under viticultural land use, market gardens and partially cleared land supporting remnant natural vegetation. Longer distance views occur over Lake Mariginiup.

- Adjacent to the site, the Lake Adams estate presents a semi-rural landscape with a mixture of residential properties and equestrian facilities, with some longer distance views over Lake Adams. South of the Lake Adams estate the landscape features recently cleared ground surrounded by remnant *Banksia* woodland vegetation which screens the longer distance views. North of the Lake Adams estate, short-distance views of pine plantations dominate views to the east, whilst short-distance views of natural forest and woodland vegetation dominate to the west.

- North of the site, Pinjar Road presents views of fully and semi-cleared, low-lying sandy land under agricultural land use, and pine plantations

The landscape to the north of the site is characterised by short-distance views of natural vegetation in varying condition, with occasional longer distance views over horticultural land use. To the south of the site, the viewscape is characteristically dominated by views across land under horticultural use.

In summary, the regional landscape is generally based on an undulating, partially vegetated landform which includes wetlands, in which the urban landscape is well established in the south with a gradation to semi-rural/rural landscapes occurring with increasing distance to the north.

3.0 LOCAL LANDSCAPE ELEMENTS

There is no formal public access through the site, and local landscape characteristics are described on the basis of views from the local road system. Four roads follow the site boundaries and present a landscape that may be characterised as described below.

(i) Wanneroo Road

East of Wanneroo Road, the land surface slopes upwards in a ridge which restricts visual access to the site to the near foreground. Remnant and replanted vegetation shelters views to the east. The site appears as parkland cleared and derelict farmland, with patches of introduced *Eucalyptus* trees. There are limited areas of natural regrowth and extensive areas of bare or minimally vegetated ground. During summer, the site appears bare and dry, however weed and pasture grass growth during the wetter months softens this harsh appearance.

(ii) Clarkson Avenue

Views across the site from Clarkson Avenue are similar to those from Wanneroo Road, although longer distance views afforded by the local topography include the natural woodland in the background.

(iii) Pinjar Road

In the southern portion, views across the site from Pinjar Road are similar to those from Wanneroo Road and Clarkson Avenue. In the northern portion, views into the site are confined to a short-distance only, but comprise native woodland and forest vegetation.

(iv) Flynn Drive

Views of the site from Flynn Drive consist of short-distance views into native woodland and forest vegetation. To the north of Flynn the landscape includes a combination of thinned woodland vegetation, horticultural land use and intermittent views into the Wanneroo Public Golf Course.

In summary, on a local basis the site presents landscape elements that may be characterised as a combination of derelict rural land and undeveloped natural vegetation. Surrounding land presents a landscape that is characterised by agricultural and rural vistas.

APPENDIX C

Noise Environment

APPENDIX C NOISE ENVIRONMENT

1.0 INTRODUCTION

Sources of noise within the site and the local environment include natural sources such as wind and songbirds together with noise from human activities including agriculture and traffic, which combine to create "background" noise. In addition to background noise, which varies in response to weather conditions, season and the diurnal cycles observed by the local community, occasionally there is additional noise in the environment which arises from recreational venues located to the north of the site. These are:

- Wanneroo Park Motor Racing Circuit
- Wanneroo Park Motorcycle Racing Circuit
- Wanneroo Motorcross Track, and
- Wanneroo Go Kart Track

In order to technically characterise the local noise environment in relation to both background noise levels and noise that may be audible within the site as a result of motor racing activities, a series of noise monitoring surveys were conducted within the site on six occasions over four dates in 1989 and 1990, being 21.10.89, 29.10.89, 26.5.90 and 27.5.90. Motor racing was in progress at one or more venues on each of the survey days. The results of the surveys are presented and explained in the following sections, and are depicted as noise level contours on Figure C1.

2.0 BACKGROUND NOISE

Background noise levels were measured at a range of locations throughout the site during the 1989 and 1990 surveys. The results of background noise measurements are shown in Table 1.

Table 1

Background Noise Measurements

Date	Time (hrs)	Measure Position	Ranged B(A) L5-L95	Average LEQ	Maximum LMAX	Weather Conditions Comments
21.10.89	1100-1300	Various	27-37	No Data	55	Slightly overcast some showers, light to gusty SE-SW winds, maximum gust 72km/hr.
29.10.89	1100-1500	Various	35-45	No Data	No Data	Heavy cloud, slight to heavy showers. Moderate SSE to SSW Swinds gusting to 41km/hr.
26.5.90	0900-1500	P9	41-45	43	47	Heavy cloud, moderate showers. Slight to gusty N winds to 63km/hr.
27.5.90	1100-1500	P5	59-65	61	68	Heavy cloud moderate showers and drizzle. N to NW winds gusting to 32 knots from NW.
27.5.90	1100-1500	P6	56-62	57	60	Heavy cloud moderate showers and drizzle. N to NW winds gusting to 32 knots from NW.
27.5.90	100-1500	P7	56-61	60	64	Heavy cloud moderate showers and drizzle. N to NW winds gusting to 32 knots from NW.

Background noise levels were measured at several locations within the site during the 1989-90 surveys, and were found to vary according to prevailing weather conditions and were also effected by localised wildlife (songbird) activity. The levels (L5-L95) recorded ranged between 27 dB(A) and 65 dB(A), but were predominantly between 35 dB(A) and 60 dB(A). The maximum level recorded was 68 dB(A).

Typically higher levels were recorded at measuring stations located close to Pinjar and Wanneroo Roads, particularly within the southern parts of the sites where vegetation has been largely cleared. Peak background noise levels were, however, recorded when birdlife was active in close proximity to the monitoring station. The audibly distinguishable contributors to background noise included wind, rain, traffic and wildlife.

It is relevant to note that the State Motorcycle Championships were in progress during measurement of the background noise levels reported for the 27.5.90, but racing activity could not be distinguished above "nearfield" noise from the wind and the rustling of trees.

3.0 MOTOR SPORT VENUES

(i) Wanneroo Park Motor Racing Circuit

The Wanneroo Park Motor Racing Circuit is located some 2km to the north of the northern site boundary within an area surrounded by natural vegetation. During the racing season approximately eight weekend race meetings are held, with three days allocated during the preceding week for practice and testing.

Noise level measurements were conducted within the site during both practice sessions and racing events associated with the National Sports Sedan Challenge on the 21.10.89, and 22.10.89. The results of noise measurements are shown in Table 2 and on Figure C1(A).

Table 2

Sound Levels Recorded on 22.10.89 [dB(A)]

Measuring Station	L1	L2	L3	L4	L5
Practice	39-46	42-49	-	-	-
Racing	35-44	40-48	35-39	30-35	-

Note: See Figure C2 for locations of the measuring stations.

Table 2 shows that racing noise is most audible within the northern parts of the site, which are closest to the WPMRC. Noise levels were found to reduce considerably with increasing distance to the south, as a result of both the effect of distance and the presence of the ridge of high ground located within the central part of the site, which has a shielding effect on noise transmission to the southern parts of the site.

(ii) Wanneroo Park Motorcycle Racing Circuit

The Wanneroo Park Motorcycle Racing Circuit is located approximately 2km north of the northern site boundary, directly between the Wanneroo Park Motor Racing Circuit and the Go Kart Circuit. During the racing season approximately six weekend race meetings are held, with three days allocated during the preceding week for practice and testing.

Noise levels within the site were measured on two occasions when motorcycle racing was in progress. The results of the 1989 survey, conducted whilst racing at the Wanneroo Motorcross Circuit was simultaneously in progress, are shown in Table 3 and on Figure C1(B).

Table 3

Sound Levels Recorded on 29.10.89 [dB(A)]

Measuring Position	L1	L2	L3	L4	L5
Noise Levels Range	44-49	45-50	37-43	30-34	33-42

These levels confirm the noise data collected for Wanneroo Park Motor Cross Track and show that noise levels during motorcross racing are highest within the northern part of the site, and fall by 10-15dB(A) at points of reception within the more southerly parts of the site.

The results of the 1990 survey, which was conducted to greater detail in terms of number of measuring positions, are shown on Table 4 and on Figure C1(C).

These data are the most comprehensive collected from the site and, together with the descriptive comments provided by the sound technician, enable the following points to be made.

- Meteorological conditions: A light northerly wind to 2km/h with overcast sky that prevailed on the day of the survey were very favourable for noise transmission into the site from the motorcycle racing circuit and may be considered to approximate the maximum noise levels that occur as a result of motorcycle racing activity.

- The results of the 1989 survey suggest that motorcycle racing creates up to 3-5dB(A) more noise within northern parts of the site than motor sedan racing at the adjacent Wanneroo Park Racing Circuit.

Table 4

Sound Levels Recorded on 26.5.90 [Lmax, dB(A)]

Measuring Station	**P1**	**P2**	**P3**	**P4**	**P5**
Noise Level	54.5	53.1	54.0	52.2	56.0
Measuring Station	**P6**	**P7**	**P8**	**P9**	**P10**
Noise Level	54.0	-	-	48.0	55.0
Measuring Station	**P11**	**P12**	**P13**	**P14**	**P15**
Noise Level	-	47.0	47.4	50.5	47.1
Measuring Station	**P16**	**P17**			
Noise Level	-	-			

- Motorcycle noise was very audible along the Flynn Drive boundary but attenuated rapidly with distance into the site, in a southerly direction.

- Within the densely wooded parts of Lot 2 racing noise was less audible and was partially masked by noise from agricultural machinery that was operating on the day of recording.

- Within the southern parts of the site, racing noise was either faintly audible or inaudible, and was masked by traffic noise from the operation of Pinjar Road and Clarkson Avenue.

(iii) Wanneroo Motorcross Track

The Wanneroo Motorcross Track (WMT) is located approximately 750m to the north of the site's northern boundary and is closer to the site than other local racing venues. However, due to the location of the track within a localised depression on the north facing aspect, noise transmission to the site is lower than from the other, more distant racing tracks. During the racing season approximately fourteen weekend race meetings are held. Practice is held on an informal basis according to need.

Noise measurements conducted within the site when the WMT was the only source of racing noise are shown in Table 5 and on Figure C1(D).

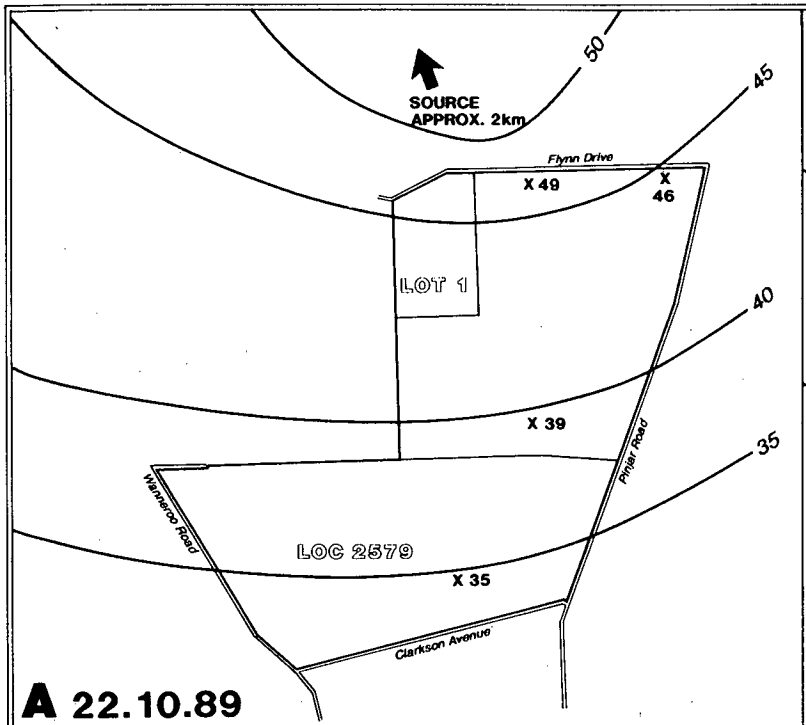
Table 5

Sound Levels Recorded for Practice on 21.10.89 and Race Day on 29.10.89 [dB(A)]

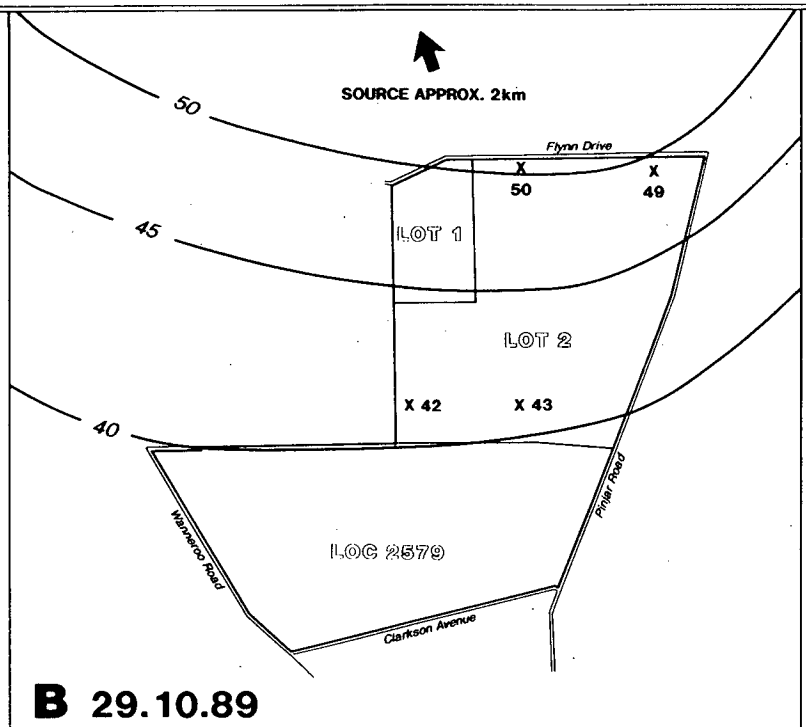
Measuring Position	L1	L2
Practice	41-45	41-48
Racing Event	42-47	43-48

iv) Wanneroo Go Kart Circuit

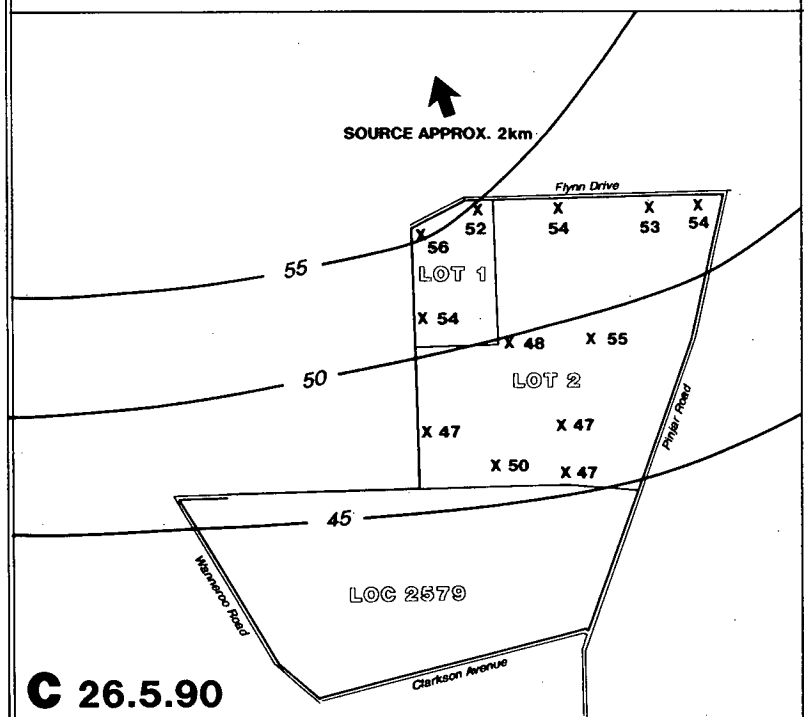
The Wanneroo Go Kart Circuit is located approximately 2km north of the northern site boundary, immediately east of the Wanneroo Park Motor Racing Circuit and the Motorcycle Track. During the racing season, approximately twelve weekend race meetings are held. Practice is held on an informal basis according to need, and kart hire is available on a daily basis. No noise measurements were recorded while the kart track was in operation, however it is anticipated that the combined noise levels from the Wanneroo Park Motor Racing Circuit and the Motorcross Circuit would be significantly higher than the noise generated from these smaller machines..



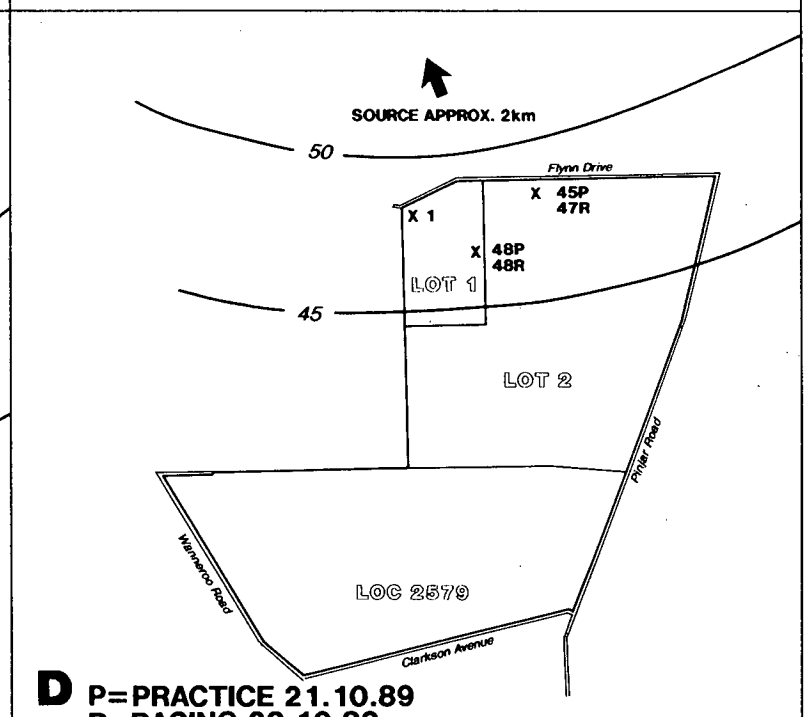
A 22.10.89



B 29.10.89



C 26.5.90



D P=PRACTICE 21.10.89
R=RACING 29.10.89

All recordings in dB (A)
(A-weighted decibels)

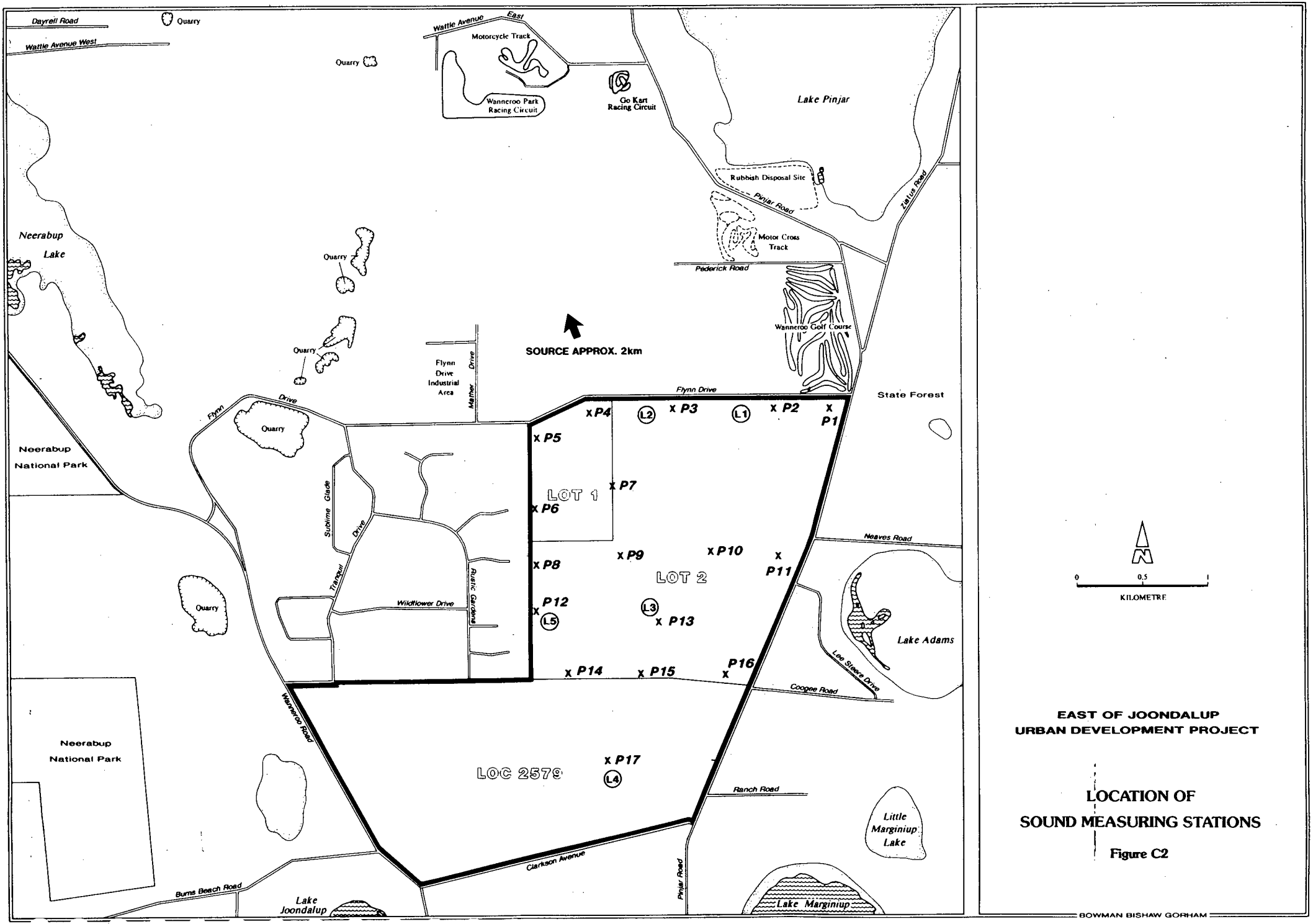
at L max
(maximum noise levels)

EAST OF JOONDALUP
URBAN DEVELOPMENT PROJECT

NOISE LEVEL CONTOURS

Figure C1

BOWMAN BISHAW GORHAM



EAST OF JOONDALUP URBAN DEVELOPMENT PROJECT

LOCATION OF SOUND MEASURING STATIONS

Figure C2

BOWMAN BISHAW GORHAM

APPENDIX D

Archaeological and Ethnographic Survey

REPORT OF AN ARCHAEOLOGICAL AND ETHNOGRAPHIC SURVEY FOR ABORIGINAL SITES NEERABUP, WANNEROO

Prepared for

BOWMAN, BISHAW & GORHAM
ENVIRONMENTAL MANAGEMENT CONSULTANTS

BY

A. MURPHY & E.M. Mc DONALD

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5 ELLEN STREET
FREMANTLE

NOVEMBER 1989

SECTION 1: INTRODUCTION

1.1 Introduction

This report presents the results of an archaeological and ethnographic survey for Aboriginal sites conducted in Neerabup, Wanneroo by McDonald, Hales and Associates for Bowman, Bishaw and Gorman (Environmental Management Consultants) during November 1989. Homeswest and its partner Yalata Nominees plan to develop a housing project in the study area.

A survey for archaeological sites was conducted by A. Murphy (assisted by L. Collard) and the attendant ethnographic survey was conducted by E. Mc Donald.

The survey did not discover any archaeological sites in the study area. However, the area does contain one site of ethnographic significance - a site of the mythological *honey possum*.

1.2 Recommendations

(a) It is recommended that the possum site be protected. It is also recommended that the custodians of the site be consulted prior to the finalisation of the development plans for the area.

(b) In the absence of other ethnographic or archaeological sites within the study area that development be allowed to proceed in areas outside the *honey possum* site.

(c) The obligation to report any archaeological sites discovered in the course of development should be noted (see sections 15 -18 Obligations Relating to Sites, Aboriginal Heritage Act 1972-1980).

(d) It is recommended, therefore, that archaeological monitoring should take place at all stages of work involving scrub clearance and earth moving.

SECTION 2: ARCHAEOLOGICAL SURVEY

2.1 Archaeological Background

A review of site files in the Aboriginal Sites Department shows that no prevoiusly recorded sites are known to lie within the survey area. Within a radius of 5km only eight sites of archaeological significance have previously been recorded. The extremely low density of recorded sites probably results from the interaction of three factors; Aboriginal land use patterns (prehistoric to present), the geomorphology of the area and current research emphasis.

2.2 Archaeological Survey Methods

The study area comprises some 500 hectares, consisting of disused pasture and natural bushland, in North Wanneroo. In the cleared portion approximately 50% of the ground surface was actually visible through the grass stems. This figure was markedly reduced (<5%) for the bushland as the late spring rains have encouraged the growth of dense understorey vegetation in the open woodland.

The survey was accomplished by traversing the area on foot. Grassed areas were systematically crossed in east-west then west-east transects with a distance of approximately 5m between the surveyors. All firebreaks, fence margins and other disturbed areas were more closely examined as these afforded an

unobstructed view of the ground surface. Patches of extremely dense and high grass were avoided due to the presence of snakes in the area. Access through the bushland was restricted to firebreaks and narrow tracks. These and less densely vegetated areas visible from them were carefully examined for traces of artefactual material.

It is estimated that 85% of the pasture and 10% of the bush was examined.

2.3 Archaeological Survey Findings

No Aboriginal sites were found in either the cleared or the bush parts of the property.

Indeed no trace of Aboriginal occupation was found within the boundaries of the survey area.

SECTION 3: ETHNOGRAPHIC SURVEY

3.1 Methodology

The survey involved the following methods:

1. Archival Research
2. Interviews
3. Site Inspection

3.2 Ethnographic Background

A search of the existing archival material held at the Department of Aboriginal Sites reveals that there are **no** recorded ethnographic sites lying directly in the area of the proposed development. Within a five kilometre radius of the survey area, there are a number of recorded ethnographic sites (habitation and mythological sites).

3.3 Ethhnographic Findings

The survey area contains one ethnographic site of mythological significance.

The site contains *honey possums* - the actual species is presently

unknown. They reportedly occupy an area on the eastern side of the property, opposite the junction of Pindar Road and Lee-Steere Drive.

The Aboriginal informant reported that the possums have a mythological significance in addition to their physical manifestation. The informant noted that there were a number of *stories* associated with the site. However, the consultation was unable to record the *stories* during the interview.

He also reported that he was concerned about the protection of the site. The informant said that he had previously contacted the former owners of the land in an endeavor to protect the site and the possums. Additionally, he had also sought help from an environmental scientist about the conservation of the possums.

The informant requested that the consultants bring the site to the attention of the developers. He also requested that he be consulted prior to development plans being finalised. The informant wishes that a conservation zone be established for the possums and the mythological site be protected within this.

The informant reported that there were no other sites of ethnographic significance within the study area.

APPENDIX E

Proposed Wanneroo Substation

Prepared by SECWA

TABLE OF CONTENTS

1.0 OBJECTIVES AND SCOPE OF THE SUBSTATION PROPOSAL

The State Energy Commission of Western Australia (SECWA) is proposing to construct a new substation in the Wanneroo area. The facility will be a strategic electrical transformation and distribution point for supplying power to the local area and comprises of a 132kV/ 22kV substation and associated 132kV transmission line and 22kV line entries. The 22kV line entries will be cabled underground. The purpose of the substation is identified as follows:

(i) To provide a site suitable for connection into and reinforcement of the 132kV transmission system.

(ii) To transform the 132kV voltage to 22kV for distribution.

(iii) To allow reinforcement of the 22kV system to support the growing suburban distribution.

SECWA is responsible for the planning, development and maintenance of an efficient electrical system to enable an economic supply of electricity to be provided throughout the state. The new substation will allow future distribution feeders to be established as the electrical load requires. The new substation is also essential to cater for the future growth of the proposed development.

2.0 NEED FOR THE PROPOSED WANNEROO SUBSTATION

The development that is occurring in the Wanneroo Shire is creating an increasing demand for electrical energy in the area. The projects proposed for Wanneroo over the next few years will exceed the capabilities of SECWA's present electrical distribution system in the area.

To meet the future electrical requirements of industrial and urban development, SECWA needs to construct a substation which will be a electrical injection point for the area and will reinforce the distribution network.

2.1 FUNCTION OF WANNEROO SUBSTATION

A substation is a facility which forms a strategic transformation point for the localised distribution of electricity.

The substation provides a location for connection into the electrical transmission network and has the facilities to perform switching and isolation of this system.

The high voltage lines of the metropolitan transmission network supply bulk power to substations. The substations transform this high voltage energy down to a lower voltage level suitable for street distribution. Typically 6-8 feeders, at this lower voltage level, emanate from the substation in various directions to supply the local area load requirements.

2.2 REQUIREMENT FOR WANNEROO SUBSTATION

Existing supplies of electrical power for residential and industrial consumption in the Wanneroo area are provided via two remote sites, Mullaloo and Yanchep Substations.

The Mullaloo Substation is limited in its capability to supply electricity to the Wanneroo area due to the physical boundary of Lake Joondalup, the distance and load from the substation causing technical problems and because the substation is approaching its full load capacity with the growing residential and town centre development of Joondalup.

The Yanchep substation is not capable of supplying the load requirements of the Wanneroo area as the distance between the two sites would cause excessive power voltage deviations exceeding SECWA supply limits.

These restrictions impose limits on the amount of power that can be supplied to the Wanneroo area.

As the proposed development will exceed the electrical supply capability of the existing system a new substation close to the load centre is required which will reinforce the distribution system to meet the anticipated power demand.

2.3 SELECTION OF THE SUBSTATION SITE

The following criteria were considered for selecting a suitable substation site:

- Close proximity to local area load centre.
- Proximity to existing transmission lines.
- Load areas covered by adjacent substations.
- Requirements for initial and future development.

Negotiations between representatives of Yatala Nominees Pty Ltd and SECWA have agreed that the proposed site meets the above criteria and development plans.

The proposed site is relatively close to the load centre of the development, is approximately 400 metres from an existing transmission line, does not conflict with adjacent substation supply areas and has provision to allow for future development facilities.

2.4 CONSEQUENCES OF NOT IMPLEMENTING THE PROPOSAL

SECWA is responsible for the supply and distribution of electricity in Western Australia. The substation will enable electricity to be provided to SECWA's customers in the proposed development and will improve the security and quality of supply for the Wanneroo area.

If the proposed substation does not proceed, SECWA will not be capable of providing the anticipated electrical load of the development because of physical, technical and environmental limitations. Provision of a new substation in the general area is required in the immediate future to meet this development and the Wanneroo area's increasing electrical demand on the distribution system.

3.0 PRINCIPAL ENVIRONMENTAL CONSTRAINTS

3.1 VISUAL INTRUSION

It is important from the social perspective that the proposed substation be visually unobtrusive.

To ensure that visual screening of the substation is achieved a buffer area around the actual substation has been provided. This buffer area will be vegetated and the substation structures kept as low as possible to minimise the visual impact of the facility. Existing trees and shrubs will also be retained wherever possible to capitalise on their screening effect.

Initially the substation will not be fully developed and vegetation in undeveloped areas retained. Subsequent development of the site will be governed by electrical power demand and timing of future developments.

A landscaping proposal for a fully utilised substation of four line criteria and complete commitment of the site has been developed to show the visual screening effect that will be retained.

This proposal and an artistic impression of how the site will look are included as Figures 1 and 2.

3.2 PUBLIC HEALTH AND SAFETY

Electromagnetic fields at 50Hz are produced by all types of power frequency electrical equipment. This includes overhead power lines, underground cables, house wiring and electrical appliances within the home.

Field strengths reduce quickly with increasing distance from the source. At ground level below many overhead lines the field strengths are similar to those produced by domestic electrical appliances.

Over the last twenty years some scientists have questioned whether electric and magnetic fields have any adverse effect upon human health and a great deal of scientific research has now been carried out to answer that question.

Research into possible health effects from magnetic fields has been conducted by scientists around the world, both in the laboratory and by studying the statistics of disease in human populations. Experiments have also been carried out on livestock and plant life.

All research to date has been extensively reviewed by competent scientific and medical bodies, including the World Health organisation, the International Radiation Protection Association and the National health and Medical Research Council of Australia. All have concluded that no causal link has been established between adverse human health effects and magnetic fields. The same is true for adverse effects on livestock and plant life.

This conclusion has been supported by leading epidemiologists and medical specialists. However, research continues and is both encouraged and monitored by SECWA.

Australian health authorities, through the National health and Medical Research Council of Australia have adopted guidelines for human exposure to electric and magnetic fields based upon known biological effects at very high field strengths. These are identical to the international guidelines published by the International Radiation Protection Authority in conjunction with the World Health Organisation.

SECWA recognises the recommended exposure limits and all its installations are designed to ensure electromagnetic fields are minimised so that members of the public will not be exposed to the fields in excess of the recommended limits.

4.0 DESCRIPTION OF SUBSTATION DEVELOPMENT

4.1 SUBSTATION SITE

The substation would be developed in a number of stages, over an extended time period. The timing and sequence of this development will depend on electrical demand growth, relative distribution of this demand and future development proposals.

The proposed substation utilises a 1.96 hectare site on the corner of Wanneroo Road and Clarkson Avenue. The site is square with 140 metre sides of which approximately 100 metres is utilised for the substation. The remaining 40 metres form the buffer zone around the substation fencing.

The initial development is required to be operational by December 1994 and is likely to consist of establishing a 132kV switchyard, turning the existing Mullaloo–Yanchep 132kV line in and out of the substation, establishing four lower voltage feeder circuits and constructing an operational building.

Ultimately up to eight lower voltage feeder circuits may be installed and two additional 132kV line entries.

4.2 LINE ENTRIES

The requirement to interconnect the substation site to 132kV transmission lines necessitates a concentration of poles in the vicinity of the site.

The initial line entries would be from the west of Wanneroo Road by turning the existing Mullaloo–Yanchep 132kV line in and out of the substation. This would achieve a Yanchep–Wanneroo circuit and a Wanneroo–Mullaloo circuit.

There is also a need in the future to establish a line from Wanneroo to the Gas Turbine Station at Pinjar. It is envisaged that this line entry would occur from the South of the site of Clarkson Avenue and would create a Pinjar–Mullaloo circuit via Wanneroo.

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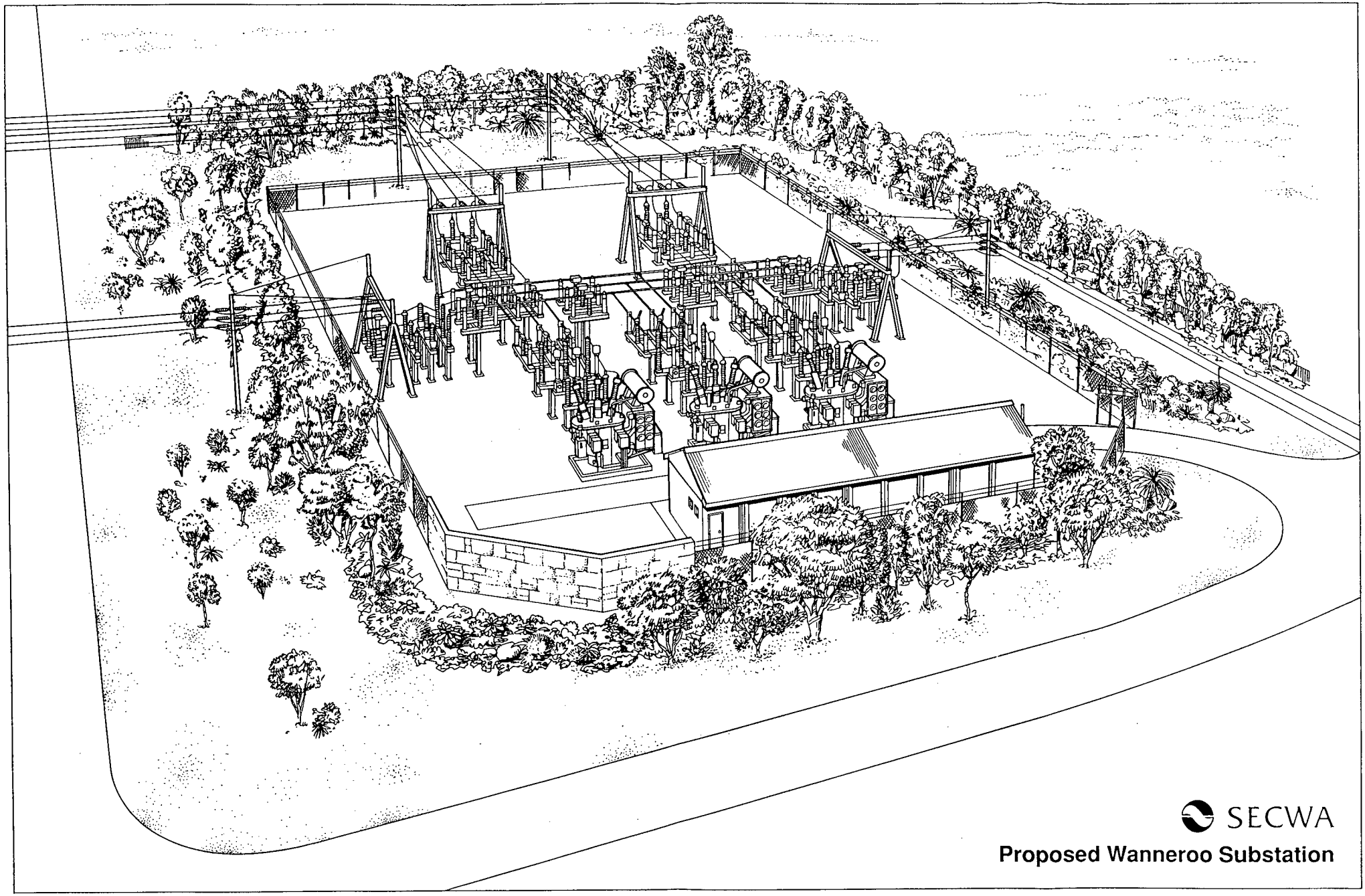
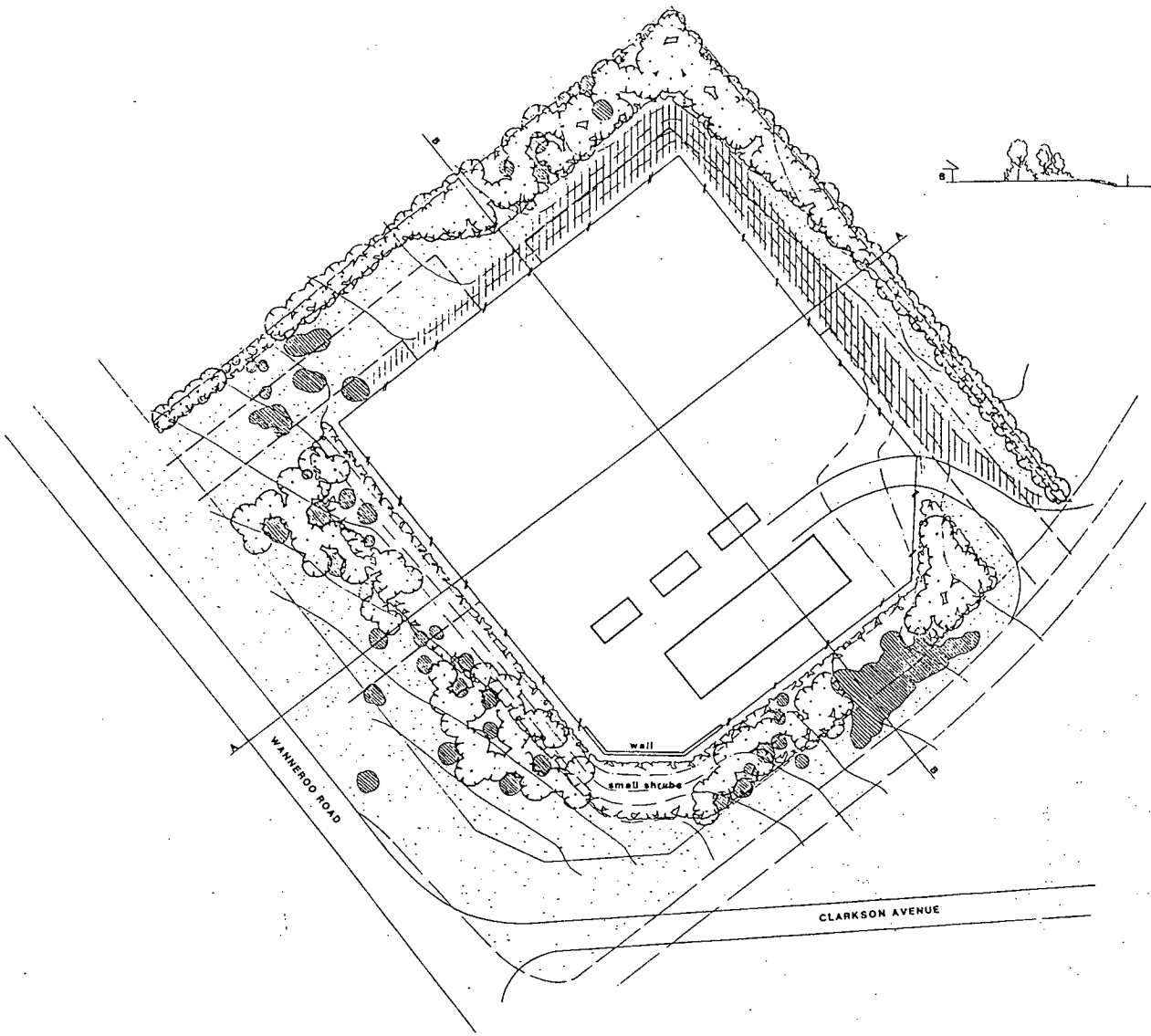
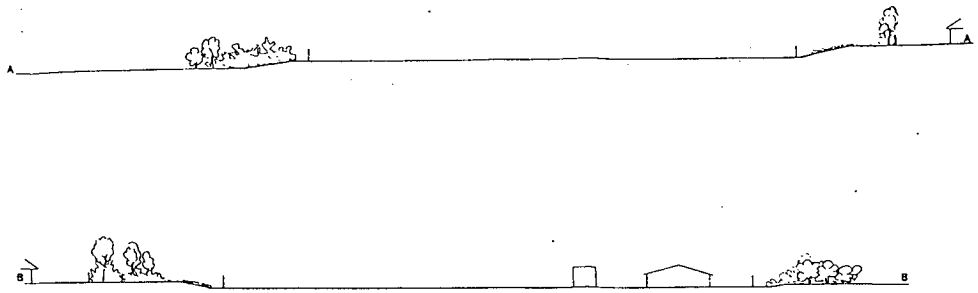

SECWA
Proposed Wanneroo Substation





LEGEND

EXISTING TREES TO BE RETAINED

PROPOSED TREES — CONSTRICTED AREAS

Eucalyptus lehmanni
" ficifolia
" leucoxylon rosea
Casuarina cunninghamiana

NON-CONSTRICTED AREAS

Eucalyptus camaldulensis
" calophylla rosea

SHRUB MATRIX — LARGE

Acacia lasiophylla
Callistemon Kings Park Special
Hakea laurina
Melaleuca armillaris

SMALL

Grevillea crithmifolia
" thelemanniana

GROUND COVER — Carpobrotis (pigface)

SLASHED GRASS

PROJECT	SECWA WANNEROO SUBSTATION
DRAWING	LANDSCAPE PROPOSALS
NO	28/90D-3
SCALE	1:500
DATE	FEB 1991

APPENDIX F

Post-Development Site Water Balance

APPENDIX F POST-DEVELOPMENT SITE WATER BALANCE

1.0 BACKGROUND

In 1988 the report "Planning for the Future of Perth Metropolitan Region" was released by the (then) State Planning Commission. The Environmental Protection Authority's (EPA) response to the report highlighted the need to incorporate environmental and resource sensitive design into future urban development. Within the response from the EPA a list of objectives for groundwater resource conservation in regional urban design, and environmental information needs for achieving the objectives, were presented (EPA, 1989).

Information requirements listed in the EPA report note that proponents of urban development projects should be required to identify:

(a) The water balance of the locality and its relationship to the regional water body, which is discussed in detail in Appendix A; and

(b) The expected groundwater rise associated with clearing and urbanisation both within and adjacent to the subject site.

In accordance with EPA advice, a post-development water balance has been prepared to assist in evaluating the effect of the proposed development upon the local and regional hydrological regime and groundwater table. A summary of the development and results of a post-development water balance for the project site is provided in this appendix.

2.0 INTRODUCTION

Urban development has the capacity to alter the average water table position of the underlying groundwater aquifer. Past experience indicates that in general, residential development within the Swan Coastal Plain can result in a rise in the local groundwater table.

The rise in elevation of the local water table may be attributed to three main factors:

(a) A reduction in evapotranspiration and interception losses due to the removal of native vegetation resulting in an increase in the portion of incident rainfall that becomes groundwater recharge,

(b) Disposal of domestic effluent by soil absorption systems,

(c) The application of imported water via irrigation with reticulated mains water, and

(d) The collection and disposal of stormwater from impervious shedding surfaces to infiltration devices such as soakwells and compensation basins, which concentrate and increase the proportion of incident rainfall that becomes groundwater recharge.

In contrast, the abstraction of groundwater for both public and private water supplies tends to counteract increased groundwater recharge and moderates water table rise caused by urbanisation.

The post-development water balance is defined herein by determining quantitative long-term projections of groundwater recharge and abstraction within the project site. Whilst some components of the water balance can be accurately predicted (eg. rainfall), other components such as evapotranspirative losses have to be estimated on the basis of research findings.

3.0 DEFINITION OF VEGETATION AND SHEDDING SURFACE AREAS

Estimated percentage areas of vegetation, roofs and paving for different land use components as presented in Cargeeg *et al.* (1987) have been adopted for use in the water balance calculations below. Table 1 summarises total areas of component land uses within the site and the areas of paving, roofs and vegetation derived for each.

Table 1

Vegetated, Roofed and Paved Areas within Proposed Development

Component Land Uses	Total Area (hectares)	Paved		Roofed		Vegetation	
		%	Area (ha)	%	Area (ha)	%	Area (ha)
Residential (medium density)[1]	655.7	13.2	86.6	18.0	118.0	68.8	451.1
District & Community Centres[1]	21.5	42.5	9.1	39.5	8.5	18.0	3.9
Shopping Centre[1]	5.5	10.0	0.6	80.0	4.4	10.0	0.6
Public Utilities[1]	1.8	15.0	0.3	10.0	0.2	75.0	1.3
SECWA Sub-station[2]	1.9	45.0	0.9	5.0	0.1	5.0	0.9
Schools[1] (Primary & Secondary)	36.0	40.0	14.4	40.0	14.4	20.0	7.2
POS[1] (Vacant Public Use)	69.9	0.5	0.3	0.2	0.1	99.3	69.5
Arterial Roads[1]	29.7	59.0	17.5	0.0	0.0	41.0	12.2
Drainage Sumps[3]	7.5	-	-	-	-	-	-
TOTALS[4]	**829.5**	**15.0**	**129.7**	**18.0**	**145.7**	**67.0**	**546.7**

Notes:

The above proportions are indicative only and subject to final Structure Plan modifications.

1 = % values adopted from Cargeeg *et al.* (1987).
2 = % values adopted from SECWA landscape plan for Wanneroo sub-station (see Appendix E).
3 = Total area of drainage sumps assumed to be open water.
4 = Total values are inconsistent with sum of category values due to cumulative rounding of category values to the nearest 0.1ha.

4.0 IRRIGATION WATER REQUIREMENTS

Irrigation will be required to maintain vegetated areas of the development both during and following establishment. These areas include:

- Public open space
- Primary and secondary school playing fields
- Landscaped areas of commercial centres (district, community and shopping centres)
- Landscaped areas of public utilities (including SECWA Wanneroo sub-station), and
- Residential gardens.

Assuming that all vegetated areas except road verges would be irrigated, the likely consumption of irrigation water within the project site may be projected by examining the water requirements of each vegetated area.

4.1 Public Open Space

In accordance with Department of Planning and Urban Development policy, 69.5 hectares of the project site will be allocated for use as public open space. Cargeeg *et al.* (1987) estimate that 99.3% of public open space and golf courses are vegetated. Average annual irrigation water consumption by Local Governments for the maintenance of recreation areas is estimated to be 30mm/week between the months October to March. (P. Cock. pers comm., Hydroplan Irrigation Drilling and Management Consultant, August 1990). Therefore it is estimated that the irrigation requirements for public open space will be approximately 461.3ML/annum.

4.2 School Playing Fields

Annual consumption of irrigation water by schools has been estimated to be 7.5ML/ha/annum based on the total area of the school (Cargeeg *et al.*, 1987). This is equivalent to

37.5ML/annum per hectare of vegetation. A total area of 36 hectares has been allocated for schools within the proposed development, therefore an estimated 270ML/annum of irrigation water will be consumed for the maintenance of school playing fields.

4.3 District and Community Centres

The total of 4.5 hectares of lands designated for development as district and community centres comprised of commercial shops and cultural facilities will be vegetated, based on percentage area estimates presented in Cargeeg *et al.* (1987) for small shops. Assuming equivalent irrigation requirements per hectare of vegetation applicable to schools, it is projected that 168.8ML/annum of water will be applied to vegetated areas of commercial centres.

4.4 Public Utilities (including SECWA Sub-station)

Michael Tooby and Associates, landscape architect for the proposed SECWA sub-station at Wanneroo (see Appendix E), advises that to aid establishment of landscape vegetation approximately $10m^3$ (0.01ML) of water will be applied weekly during the first summer following planting. It is expected that the application of irrigation water during the second summer after planting will be markedly less and possibly discontinued thereafter.

Assuming other public utilities would be similarly landscaped and therefore have equivalent water requirements per hectare of vegetation, it is estimated that irrigation water applications to public utilities will total a maximum of approximately 0.7ML/annum during landscape establishment, and be reduced to zero in the long term.

Scheme water may be used for irrigation water at the sub-station, recognising that the installation of a groundwater abstraction bore will most likely be uneconomic for the supply of the small quantities of water required.

4.5 Residential Gardens

Average irrigation water consumption by a Perth residence has been estimated to be 0.113ML/annum (Metropolitan Water Authority, 1985). The project site will support 8,000 to 9,000 lots. Therefore following development it is predicted that annual domestic water consumption for irrigation will be approximately 904ML to 1,017ML.

5.0 RECHARGE FROM VEGETATED AREAS

Removal of native vegetation and substitution with grass and gardens will alter aquifer recharge beneath the project site. Recognising that following development the project site will support various forms of vegetation, a conservatively high estimate of recharge may be projected by assuming that vegetated areas will be predominantly turfgrass.

Investigations conducted within the Gnangara area indicate that between 44% and 66% of winter (May to August) rainfall to grasslands becomes recharge (M. Sharma, CSIRO, pers. comm., September 1989). Groundwater recharge beneath irrigated turfgrass areas will differ considerably between winter and summer.

Based on the above, winter groundwater recharge beneath vegetated areas within the project site will be approximately 1,481.8ML/annum to 2,222.7ML/annum.

McFarlane (1981) estimated that 10% of total water (irrigation and rainfall) received by residential gardens during summer months (September to April) becomes recharge. Applying this factor, it may be estimated that recharge beneath irrigated vegetated areas during summer would be approximately 309.8ML/annum to 321.2ML/annum. Road reserves will not be irrigated and therefore will not contribute significantly to groundwater recharge during summer.

Therefore, following development, the total annual recharge beneath vegetated areas of the project site will be within the range 1,791.6ML/annum to 2,543.9ML/annum.

6.0 RECHARGE FROM SHEDDING SURFACES

Shedding surface such as roofs, driveways, roads, carparks and playing courts increase the proportion of rainfall that becomes recharge. This is caused by the collection then concentrated disposal of stormwater to soakage and infiltration basins. Consequently, the potential for stormwater to evaporate is reduced whilst infiltration and hence recharge potential is increased.

Within treeless areas, Cargeeg *et al.* (1987) estimate 81% of incident rainfall to roofs and paved surfaces becomes recharge. Multiplying these factors by projected shedding surface areas (Table 1), and using the average annual rainfall for Perth of 869mm, it is estimated that groundwater recharge from roofs and paved surfaces would be approximately 1,938.5ML/annum. An additional 65ML/annum of rainfall is estimated to become recharge assuming that 100% of incident rainfall to drainage sumps becomes recharge.

7.0 GROUNDWATER ABSTRACTION

The site is located within the Carramar sub-area of the Wanneroo Groundwater Area. Before groundwater abstraction is allowed within this area a licence must be obtained from the Water Authority of Western Australia. In 1989, 80% of an interim abstraction limit of 2000ML/annum had been allocated for the Carramar sub-area (Miotti and Hopkins, 1989). The following long term projection of groundwater consumption within the project site indicates that the remaining 400ML of the sub-area abstraction will not support the long term irrigation water requirements of the development.

7.1 Non Residential

Following development, groundwater abstraction within the project site would be primarily for the irrigation of vegetated areas. The irrigation requirements to maintain these areas are presented in Table 2.

Table 2

Groundwater Abstraction for Irrigation of Non-Residential Vegetated Areas

Land Use	Irrigation Requirements (ML/annum)
District, Community and Shopping Centres	183.8
Schools	270.0
Public Open Space	461.3
TOTAL	**915.1**

7.2 Residential

Following development, residents of the project site may also choose to install shallow groundwater bores to irrigate lawns and gardens. The maximum quantity of groundwater that will be abstracted by residents for the irrigation of gardens has been estimated to be approximately 289ML/annum to 326ML/annum. This quantity has been projected for total occupancy of the project site using a mathematical model developed by CSIRO, as part of the Domestic Water Consumption in Perth study (Metropolitan Water Authority, 1985). The model and the derivation of projected private groundwater abstraction for irrigation purposes is described as follows.

Factors which influence the number of private bores within an area have been identified to include (Metropolitan Water Authority, 1985):

- Public attitude
- Depth to the water table in the area (and therefore drilling cost)
- The average dwelling age within the area
- The average dwelling are in the area
- Percentage of single-detached dwellings in the area.

These factors have been formulated into Equation 1 below, which can be used as a predictive model for the estimation of percentage bore ownership within an area.

Equation 1: % Bore Ownership = -201+7.7 (AT) -0.91 (G) +12.0 (DA) +1.0 (I) +0.5 (DT)

where:

AT = attitudinal score towards bore ownership

G = depth to the water table

DA = dwelling age (coded to)

- less than 1 year = 1
- 1 year to less than 3 years = 2
- 3 years to less than 6 years = 3
- 6 years to less than 20 years = 4
- more than 20 years = 5

I = income (1981 A$,000)

DT = percentage of single detached dwellings

Variables utilised in determining the maximum percentage bore ownership within the proposed development are listed as follows:

AT = 16.8 (After G. Syme, CSIRO, pers. comm. September 1989)
D = 25 metres (estimated average water table depth)
DA = 5
I = 16 (after G. Syme, CSIRO, pers. comm. September 1989)
DT = 100

Computation of the model utilising these variables predicts that a maximum of 32% of the projected 8,000 to 9,000 residence population will install private bores. This equates to 2,560 - 2,880 groundwater bores. Assuming an average irrigation rate of 0.113ML/annum per residence (Metropolitan Water Authority, 1985), 289ML/annum to 326ML/annum of groundwater will be abstracted from the superficial aquifer underlying the project site for the purpose of household garden irrigation.

8.0 SUMMARY

Following the proposed residential development of the project site it is estimated that nett recharge to the underlying aquifer would be between 2,569ML/annum and 3,355ML/annum. Table 3 provides a summary of predicted annual recharge and groundwater abstraction rates for the various post-development land use components of the site.

Table 3

Summary of Post-Development Groundwater Recharge and Abstraction

Land Use	Recharge[1] (ML/annum)	Abstraction (ML/annum)	Nett Recharge (ML/annum)
Residential	2,862 to 3,483	289 to 326	2,536 to 3,194
Commercial/Cultural Centres	188 to 195	169	19 to 26
Public Utilities	16 to 20	0	16 to 20
Schools	250 to 261	270	-20 to -9
Public Open Space	254 to 349	461	-207 to -112
Arterial Roads	156 to 173	0	156 to 173
Drainage Sumps[2]	65	0	65
Total[3]	**3,795 to 4,544**	**1,189 to 1,226**	**2,569 to 3,355**

Notes:

The above proportions are indicative only and subject to final Structure Plan modifications

1 = Calculated by the addition of recharge from roofed, paved and vegetated areas within each proposed land use category.

2 = Recharge via direct rainfall only.

3 = Total values may be inconsistent with sum of category values due to cumulative rounding of category values to the nearest megalitre.

Nett groundwater recharge minus abstraction beneath the project site in its current state has been estimated to be between 1,288ML/annum and 3,089ML/annum (Appendix A). Accordingly, annual recharge may increase by up to 1,281ML/annum (99%). Therefore groundwater recharge from the project site may increase considerably.

From a regional perspective, the volumetric estimates of nett groundwater recharge represent a 1% increase to current annual aquifer recharge within the Wanneroo Groundwater Area.

Therefore whilst residential development of the project site may have considerable effect upon the local hydrological regime, the effect on a regional scale would be relatively marginal.

Progress towards the predicted water balance would be incremental and gradual due to the staged release of land for purchase by the public over many years. Moreover, the proposed development is only one of many factors that has the potential to modify the existing local and regional hydrological regime.

Significantly, computer modelling conducted by the Water Authority of W.A. (Miotti and Hopkins, 1989) has indicated that the likely combined effect of future groundwater usage and land development for urban purposes within the Wanneroo area would be an increase in the average height of the water table.

Long term projections of groundwater requirements for the maintenance of vegetated areas within the project site would exceed interim abstraction limits currently employed within the locality. The expected increase in nett recharge however, would more than compensate for this demand and therefore would enable abstraction requirements to be met without endangering the groundwater resource or local wetlands.

9.0 REFERENCES

Cargeeg, G.C., Boughton, G.N., Townley, L.R., Smith, G.R., Appleyard, S.J. and Smith, R.A. (1987). Perth Urban Water Balance Study Volume 1 - Findings. Water Authority of Western Australia, Perth.

EPA (1989). Environmental Protection Authority Comments on Planning for the Future of the Perth Metropolitan Region. Bulletin 404, Environmental Protection Authority, Perth, Western Australia.

McFarlane, D.J. (1981). The effects of urbanisation on groundwater levels and chemistry in Perth, Western Australia. IN:. Whelan, B. (Ed) Groundwater Resources of the Swan Coastal Plain, 1981: Proceedings of the Symposium, Commonwealth Scientific and Industrial Research Organisation, Perth.

Metropolitan Water Authority (1985). Domestic Water Use in Perth, Western Australia. Metropolitan Water Authority, Perth.

Miotti, J. and Hopkins, D. (1989). Review of Groundwater Availability - Wanneroo. Water Authority of Western Australia, Water Resources Directorate, Groundwater Branch. Report No. WG 80 .

APPENDIX G

EPA Terms of Reference for the PER

PROPOSED URBAN DEVELOPMENT, CARRAMAR HEIGHTS/NEERABUP

PUBLIC ENVIRONMENTAL REVIEW GUIDELINES

1. Overview

In Western Australia all environmental reviews are about protecting the environment. The fundamental requirement is for the proponent to describe the proposed development, to discuss the potential environmental impacts of the proposal, and then to describe how those environmental impacts are going to be managed so that the environment is protected.

If the proponent can demonstrate that the environment will be protected then the proposal will be found environmentally acceptable; if the proponent cannot show that the environment would be protected then the Environmental Protection Authority (EPA) would recommend against the proposal.

Throughout the process it is the aim of the EPA to advise and assist the proponent to improve or modify the proposal in such a way that the environment is protected. Nonetheless, the environmental review in Western Australia is proponent driven, and it is up to the proponent to identify the potential environmental impacts, and design and implement proposals which protect the environment.

For this proposal protecting the environment means that the important natural and social values associated with the site, including the that portion of the Gnangara Mound underlying the site, are protected. Where they cannot be protected, proposals to mitigate the impacts are required.

2. Purpose of PER

The primary function of a PER is to provide the basis for the Environmental Protection Authority.to provide advice to the Government on protecting the environment. An additional function is to communicate clearly with the public so that the EPA can obtain informed public comment. As such, environmental impact assessment is quite deliberately a public process. The PER should set out the series of decisions taken to develop this proposal at this place and time, and why.

3. Objectives of the review

The Public Environmental Review should have the following objectives:

* to place this project in the context of the environmental values of the region;

* to explain the process which led to this site being chosen for development at this time;

* to set out the environmental impacts that this project may have; and

* for each impact, to describe any environmental management steps the proponent(s) believes would avoid, mitigate or ameliorate that impact.

The PER should focus on the major issues and anticipate the questions members of the public will raise. Data describing the environment should directly relate to the discussion of the potential impacts of the proposal. Both should then relate directly to the actions proposed to manage those impacts.

4. Key issues

There are a number of key issues associated with this project, and the PER should clearly identify these. The content of the succeeding sections are then determined by their relevance to these key issues.

In this case the key issues should included, but not necessarily be restricted to:

* the potential for pollution of the ground and surface water resources, including downstream wetlands;

* the significance of the native flora and fauna of the site; and

* traffic management.

Other key issues raised during the preparation of the report should also be included.

5. Structure of the PER document

The following is a guide to the information required for presentation in the report.

5.1 Introduction
This section should briefly indicate the location, background and objectives of the proposal. It should also included a discussion of the purpose of the PER with regard to environmental review.

5.2 Description of the existing environment
This section should be a thorough report on investigations into the project area, and include all components of the environment affected by this proposal, such as:

* indigenous flora and fauna on the site and its conservation value on a local and regional scale;
* dieback status of the site
* exotic flora and fauna on the site and its impact within the existing environment.
* the hydrology of the site including:
    - ground/surface water information and drainage patterns; and
    - patterns of groundwater use in the area.
* the topography of the site including any unique landforms or areas of landscape interest.
* land tenure in the area.
* noise levels on the site, particularly with regard to the Wanneroo Park Racing Circuit and major roads in the area.
* historical/anthropological significance of the area.
* current human use patterns and related management issues.
* relationship to the MRS Amendment.

5.3. Project Description
This section should cover all facets of the proposed development and should include the following:

* the timing and stages of development.
* servicing of the development.
* general design of the development including housing densities and location of areas of Public Open Space.
* environmental controls such as the minimisation of vegetation clearing.

5.4. Environmental Impacts
This section deals with the identification of impacts and their management. Environmental impacts may occur on any section of the environment including surface and ground water bodies, flora and fauna, human use and landforms. Impact identification at this stage will

result in improved implementation of management programmes, and thus impact prediction should be as comprehensive as possible.

The following list is an indication of some possible impacts but is by no means exhaustive.

Hydrological Impacts
* modifications to the drainage regime.
* the potential for pollution of ground and surface water resources including downstream wetlands.
* the consequences of urbanisation on the groundwater mound.
* potential changes in water levels in nearby wetlands

Impacts on Flora and Fauna
* the significance of native flora on the site and the consequences of its destruction/modification.
* the significance of habitat loss for native faunal species.

Visual amenity
* modification of landscape for construction activities.
* replacement of rural land and native vegetation regime with urban development.

Traffic Management Impacts
* increased traffic on Pinjar Road and other roads in the area currently with relatively low traffic flows.

After the environmental impacts have been identified, integrated management programmes and techniques need to be developed to minimise or negate these. To be effective, the management of environmental impacts should be an integral, well planned part of the project as a whole. Long term management (of areas of remnant vegetation for example) should also be discussed.

5.5 Conclusion
This should be a synthesis of the overall environmental impact of the proposal and how it has been addressed to make the project environmentally acceptable.

5.6 Plans
Detailed plans of the site should be included showing:
* existing land uses including vegetation areas and type.
* adjacent land uses.
* residential development layout.
* roads and services.
* existing groundwater contours and any predicted changes.

6 Environmental Commitments

A numbered list of environmental commitments drawn from the PER should be included at the end of the document. The list of commitments is a summary of environmental management procedures that the proponent(s) will undertake as part of the project.

The summary of Commitments should be concise, and take the form of:

* who will do the work;

* what that work is;

* when the work will be carried out; and

* to whose satisfaction the work will be carried out.

All actionable and auditable commitments made in the body of the document should be included in this list Further information on the general form and structure of the commitments can be obtained from the EPA during the formulation of the document

7 Guidelines

A copy of the final guidelines should be attached at the end of the PER.

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