Drainage Management in South Jandakot and for the Beeliar Wetlands

Report to the Environmental Protection Authority
by
A Technical Advisory Group

Environmental Protection Authority
Perth, Western Australia
Bulletin 371 March 1989

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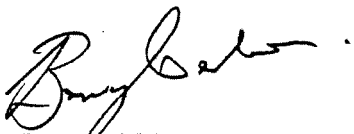
FORWARD

The Environmental Protection Authority is currently examining a drainage management plan submitted by the State Planning Commission for land east of Thomsons Lake, South Jandakot. The drainage management plan outlines drainage mechanisms intended to allow urban development of the land. Public submissions were sought on the plan by the Environmental Protection Authority, closing 20 January 1989.

The Environmental Protection Authority established a Technical Advisory Group to provide advice on the plan, in particular its ability to protect the Beeliar wetlands. The Technical Advisory Group has reported, and the Environmental Protection Authority has decided to release this report for public information. It should be noted that the report is an advisory document and that the Environmental Protection Authority has not yet determined whether it supports the recommendations it contains.

The Environmental Protection Authority is reviewing the Technical Advisory Group's report, the proponent's response to that report, and submissions received during the public review period, and will be reporting to the Minister for Environment. The Environmental Protection Authority will advise the Minister whether it believes the drainage management plan is satisfactory and in particular whether water levels in the urban areas would be adequately controlled, the Beeliar wetlands protected, and surplus water put to good use.



B A CARBON
CHAIRMAN
ENVIRONMENTAL PROTECTION AUTHORITY

CONTENTS

CONTENTS (Cont'd)

APPENDICES

TABLES

TABLES (Cont'd)

FIGURES

ABBREVIATIONS USED

BRPCC	-	Beeliar Regional Park Consultative Committee
CALM	-	Department of Conservation and Land Management
EPA	-	Environmental Protection Authority
MRD	-	Main Roads Department
MRS	-	Metropolitan Region Scheme
SPC	-	State Planning Commission
TAG	-	Technical Advisory Group
WA of WA	-	Water Authority of Western Australia.

i SUMMARY AND RECOMMENDATIONS

The Technical Advisory Group (TAG) was convened by the Environmental Protection Authority (EPA) in December 1988 to provide advice on the drainage management plan submitted by the State Planning Commission (SPC) for urban development in South Jandakot. The drainage management plan related to a proposed Metropolitan Region Scheme (MRS) Amendment which would rezone an area east of Thomsons Lake from Rural to Urban, and it outlined drainage mechanisms intended to protect wetlands within the Beeliar Regional Park. The terms of reference for the TAG were to examine the drainage management plan and to advise on:

. the capability of the plan to protect the Beeliar wetlands; and

. the availability of options to use and dispose of the drainage waters.

As a consequence of consideration of information obtained from published documentation, expert briefings, a field inspection and crude models of nutrient and water flow, the TAG advises the EPA that, while the concept of the Beeliar Compensating Channel has some merit, the drainage management plan in its present form does not demonstrate that the Beeliar wetlands would be adequately protected. That is, the TAG does not believe that the Ministerial Conditions applying to the proposed MRS rezoning have yet been met.

The TAG believes however, there is a very urgent need to remove the excessive water now accumulating in the Beeliar wetland chain as a consequence of urbanisation. There is a need for active management of these wetlands to improve the quality and quantity of water in them. Some method to conduct the water away from the wetlands is required.

There is a need to develop an overall drainage management plan for the catchments that drain into the Beeliar wetlands. The TAG believes that the Water Authority of WA (WA of WA) should exercise its statutory responsibilities for this task and immediately undertake active water management in the area.

In order for the proposed MRS Amendment rezoning and drainage management plans to be set in proper context, the TAG believes that a land use and water resource management strategy should be developed for the Jandakot groundwater mound by the SPC, the Department of Conservation and Land Management (CALM) and the WA of WA with advice from EPA. The strategy should identify areas suitable for development, conservation and groundwater protection.

The TAG believes that, should urban development proceed in the area proposed, then it should proceed on a catchment by catchment basis, commencing with the area of high depth-to-water-table based on the Hird Road wetland catchment, and using best design principles and incorporating facilities to control nutrients.

Insufficient information and time were available to examine the options for use and disposal of drainage waters.

It is important that the efforts of the TAG are sustained to achieve resolution of the issues raised as quickly as possible.

The TAG has made specific recommendations relating to specific components of the issue of drainage in the Beeliar wetlands and South Jandakot area. Our recommendations are:

RECOMMENDATION ONE

The TAG recommends that the Environmental Protection Authority request the Water Authority of WA undertake active management of water quantity and quality in the North Lake to Yangebup Lake area, both for the protection of these wetlands and to avoid flooding.

RECOMMENDATION TWO

The TAG recommends that the Environmental Protection Authority request the Beeliar Regional Park Consultative Committee to advise on criteria for the protection of the wetlands of the Beeliar Regional Park as a matter of priority. Until alternatives are available the TAG recommends that the criteria presented in this report are used.

RECOMMENDATION THREE

In view of the high conservation value of Kogolup Lake, the TAG recommends that it should not be used as a storage basin.

RECOMMENDATION FOUR

The TAG advises the Environmental Protection Authority to request a specific study on Lake Yangebup, preferably in conjunction with the Department of Conservation and Land Management and the Cockburn City Council. The study should develop a plan of action to overcome the water quality and quantity problems currently present in this Lake.

RECOMMENDATION FIVE

The TAG advises the Environmental Protection Authority that before the rezoning and drainage plans are finalised there should be a land use and water resource management strategy (integrated catchment management plan) developed for the Jandakot groundwater mound by the State Planning Commission, Department of Conservation and Land Management & Water Authority of Western Australia with advice from the Environmental Protection Authority. This strategy need not go into detail initially, but should aim at identifying areas immediately suitable for residential development, conservation and groundwater protection.

RECOMMENDATION SIX

The TAG recommends that the Environmental Protection Authority request the Water Authority of Western Australia to exercise its statutory responsibilities for water resource management and arterial drainage, to take over the development of the drainage management plan for both the South Jandakot area and the Beeliar wetlands. Furthermore, the costs of preparing the plan, carrying out monitoring and assessment, catering for any special environmental provisions and the implementation of the plan, should be incorporated in a special headworks contribution levy payable before any subdivision development is approved.

RECOMMENDATION SEVEN

The TAG recommends that the Environmental Protection Authority request the Main Roads Department to provide design details of the drainage systems to control runoff from the Kwinana Freeway extension over the Jandakot groundwater mound. It is important that the design of the Freeway drains is compatible with the arterial drainage system and management strategy, particularly for the containment of any accidental spillages or situations hazardous to groundwater.

RECOMMENDATION EIGHT

The TAG advises the Environmental Protection Authority that it believes that the Ministerial conditions applying to the proposed Metropolitan Region Scheme Amendment for rezoning the South Jandakot area have not yet been met.

RECOMMENDATION NINE

The TAG recommends that the Beeliar Compensating Channel as proposed should not be approved, but that alternative piped and open drainage systems need to be investigated to regulate water quantity and quality in the Beeliar wetlands.

RECOMMENDATION 10

The TAG recommends to the EPA that should urban development proceed prior to the finalisation of an Environmental Protection Policy, then:

- it should proceed on a catchment by catchment basis commencing with the area of high depth-to-water-table based on the Hird Road wetland catchment as illustrated in Figures 8 and 9;

- the best design principles for groundwater protection should be incorporated (see Appendix 3);

- the developer, in consultation with the Environmental Protection Authority and the State Planning Commission, should install facilities to prevent, treat, remove or otherwise contain nutrients within the urban area;

- the sale of lots should not proceed until a drainage mechanism from the estate is in place, and until a pump station has been installed to remove excess water; and

- the development and drainage from it should be monitored and extension of the urban rezoning should be conditional on successfully demonstrating that criteria with respect to drainage can be achieved on an ongoing basis.

1. INTRODUCTION

1.1 BACKGROUND

The proposals for development of the land east of Thomsons Lake were assessed by the Environmental Protection Authority (EPA) in May 1987 and reported in Bulletin 277. The following reports outlined the development proposals:

- State Planning Commission (1986), "Thomsons Lake Urban Structure Study", SPC, Perth, Western Australia.

- Sinclair Knight & Partners (WA) Pty Ltd and G B Hill & Partners Pty Ltd (1987), "South Jandakot Development Water Resources Management Plan".

The EPA concluded that the proposed urban cell to the east of Thomsons Lake was acceptable provided residential development therein would be under appropriate control. In particular, the EPA recommended that, prior to the initiation of any rezoning proposals for urban development, a satisfactory drainage scheme should be prepared.

This recommendation was endorsed by the Minister for Environment in October 1988 when he set the conditions to be met for the amendment of the Metropolitan Region Scheme (MRS), requiring inter alia that:

"1. Prior to the initiation of rezoning and reservation proposals, the proponent shall outline, to the satisfaction of the Minister for Environment a proposal for a drainage management plan for the South Jandakot area, which shall establish a package of mechanisms (including monitoring) to control water levels:

   (1) In the proposed urban areas, which is acceptable to the Water Authority of Western Australia.
   (2) In the Thomson Lake open space area and other wetlands within the proposed Beeliar Regional Park, which is acceptable to the Environmental Protection Authority of Western Australia;

   this outline of the proposal shall be made available to the public by the proponent, prior to the rezoning being advertised.

2. Finalisation of the proposed rezoning and reservation shall not occur, until the drainage management plan referred to in condition 1 has been prepared to the satisfaction of the Environmental Protection Authority, Water Authority of Western Australia and the Department of Conservation and Land Management."

In November, 1988 the State Planning Commission (SPC) advertised an amendment to the MRS to rezone the land east of Thomsons Lake to Urban. That initiative was accompanied by release for public comment of a preliminary plan for the management of the drainage waters prepared for the SPC by G B Hill & Partners Pty Ltd. The plan outlined development of the Beeliar Compensating Channel (see Figure 1) in conjunction with upstream urban drainage (see Figure 2).

The EPA called for public submissions on the drainage scheme to assist it in determining whether the plan could be implemented to the EPA's satisfaction. An independent engineering assessment of the drainage scheme was completed by Wood & Grieve Pty Ltd, and this document was made available to the public. The public review period closed on 20 January 1989.

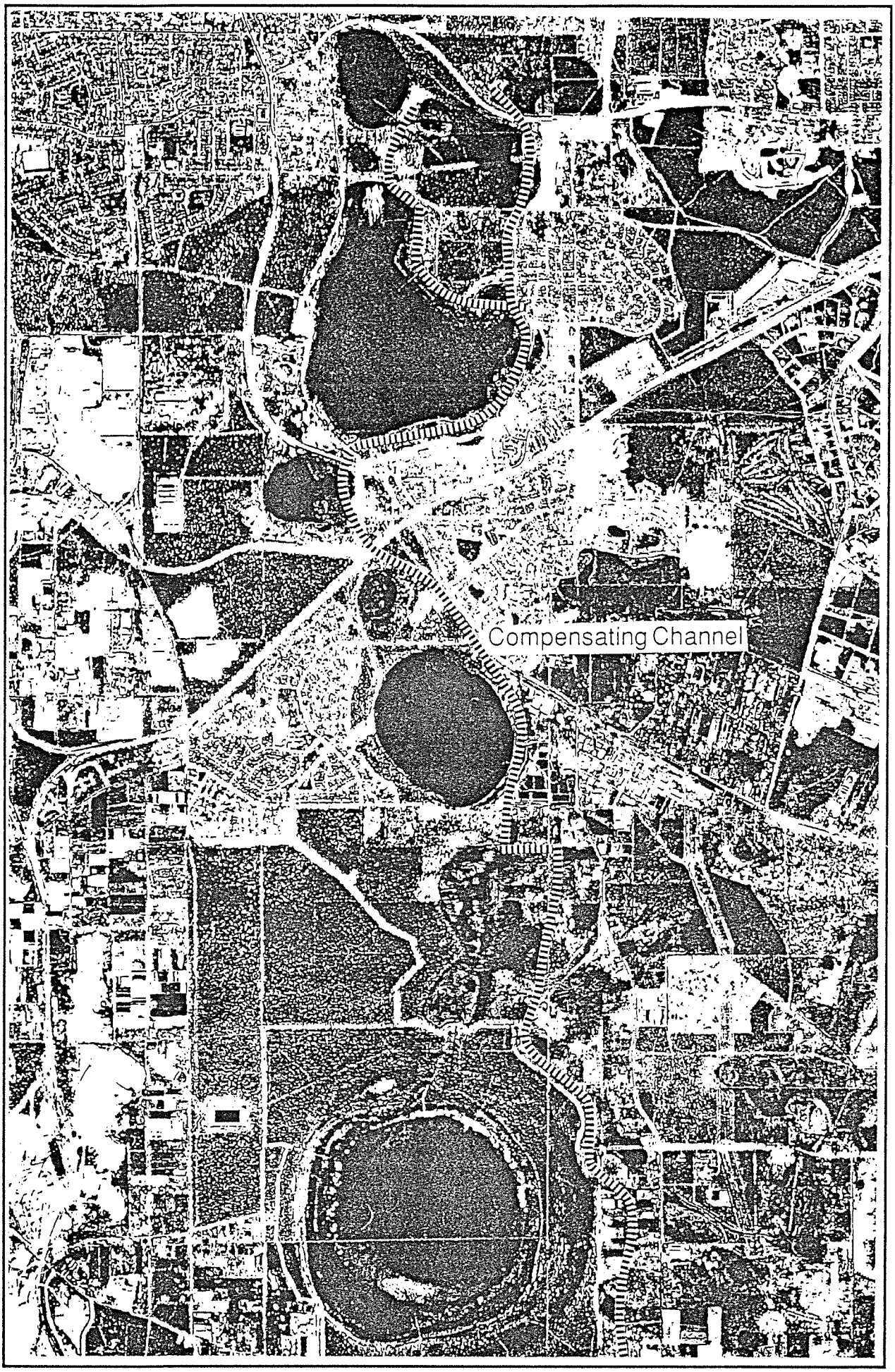


Figure 1. Proposed Beeliar Compensating Channel (aerial photograph).

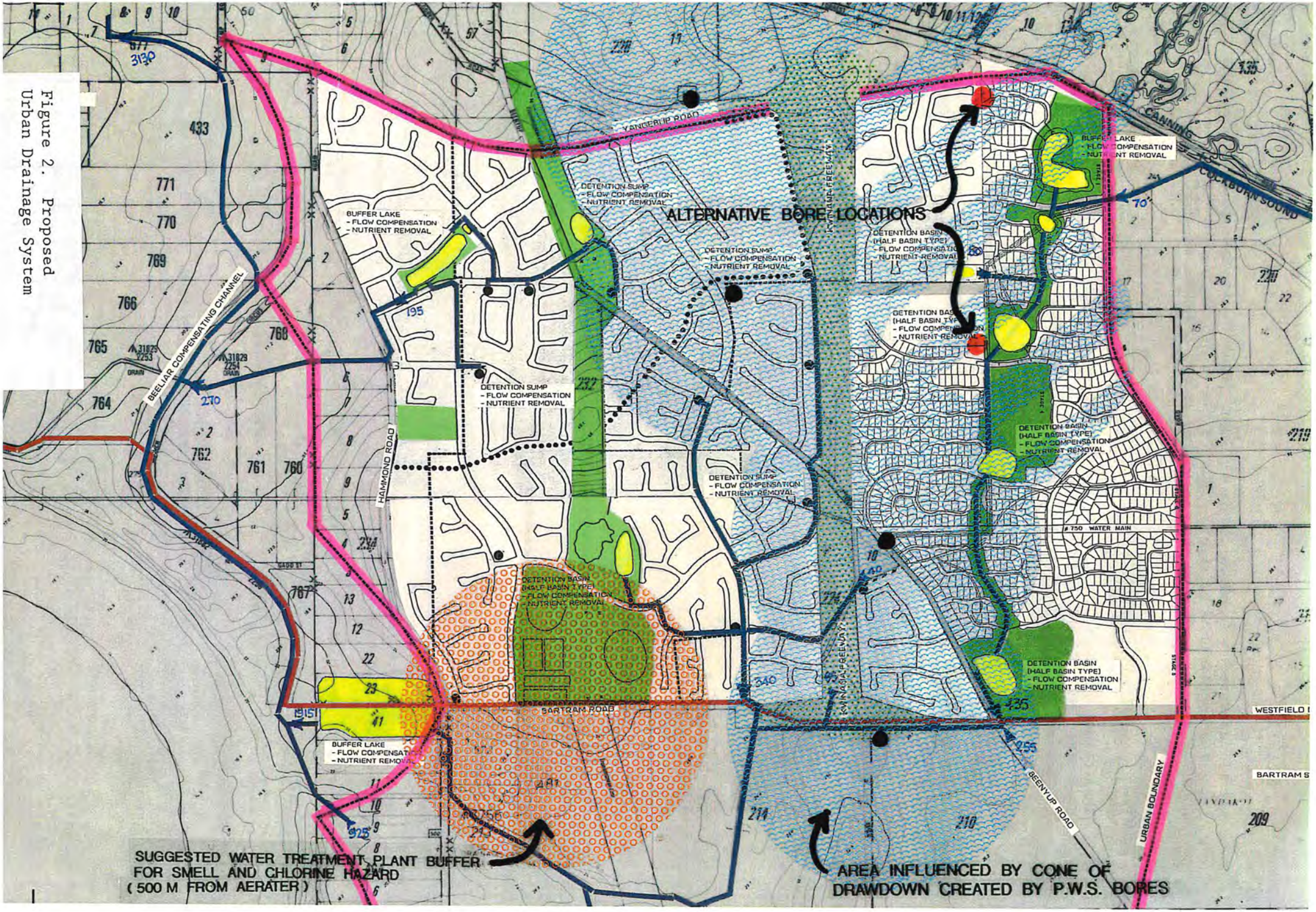


Figure 2. Proposed Urban Drainage System

The EPA convened a Technical Advisory Group (TAG) to provide advice separate from the public submissions. The TAG was asked to examine the documents above and to comment upon the capability of the drainage management plan to protect the environment.

1.2 TERMS OF REFERENCE

The terms of reference of the TAG were to examine the drainage management plan for the South Jandakot development area and in particular the water management proposals for the Beeliar wetlands and advise on:

- the capability of the drainage management plan to protect the wetlands; and
- the availability of options to use and dispose of the drainage waters.

1.3 MEMBERSHIP

The Advisory Group members were:

Dr David Bennett (Chair)
Mr Roger Bulstrode
Mr Gordon Graham
Prof Philip Jennings
Mr Jeffrey Spencer
Dr Ray Wallis

The members of the Advisory Group were chosen by the EPA for their personal expertise and experience. This report reflects the views of the individuals and not the policies of the organisations with which they are affiliated.

1.4 ACKNOWLEDGEMENTS

The Advisory Group was greatly assisted in its work by briefings given by the following:

Sinclair Knight & Partners Pty Ltd Consulting Engineers	Mr R Webley Mr I Lee Mr P Bowyer
G B Hill & Partners Pty Ltd Consulting Engineers	Mr J Paton Mr I Weaver
Department of Civil Engineering University of Western Australia	Mr M Hollick
Department of Urban and Regional Planning Curtin University	Mr D Hedgecock
Division of Water Research CSIRO	Mr J Thomas Mr C de Vries
City of Cockburn	Mr S Hiller

State Planning Commission	Mr D Matthews Mr D Everall
Water Authority of WA	Mr K Taylor Mr D Vodanovic
Environmental Protection Authority	Dr R Humphries

Special assistance was provided to the Advisory Group by the following:

Environmental Protection Authority	Mr R Van Delft Mr B Stewart Ms M Andrews Word Processing Section
Water Authority of WA	Mr B Bradshaw

1.5 METHODOLOGY

This report is the outcome of six weeks consideration and discussion of information obtained from published documentation, expert briefings and a field inspection. It assumes a knowledge of the contents of documents mentioned in Section 1.1 (Background). Other publications containing useful information are listed in Section 7 (References).

The TAG considered that the way to approach the terms of reference was firstly to examine in general the planning issues inherent in the proposal to rezone the South Jandakot area (Section 2), then to look in detail at the Beeliar wetland chain to determine, as far as possible, what constituted protection (Section 3). Against this background the TAG then examined and evaluated the proposed drainage scheme (Section 4) and discussed items which required attention (Section 5). Finally the conclusions and recommendations of the study are brought together in Section 6.

The appendices contain some of the additional information gathered by the TAG.

2. PLANNING ISSUES

It is important to briefly look at some of the planning issues that should be addressed before a significant area is rezoned from rural to urban under the Metropolitan Region Scheme (MRS).

Many issues can be resolved by adopting generally acceptable technical solutions; e.g. major water supply pipeline route, road interchange location. However, planning issues that involve an evaluation of short and long term social and community benefits can rarely be resolved using straight forward technical or economic reasoning; e.g. extensive filling along a river foreshore , urban development within key water supply catchment areas.

Furthermore, when a development proposal is likely to have a detrimental and/or virtually irreversible impact on natural resources, it is crucial that the issues are only resolved after obtaining expert advice and public debate. It is of fundamental importance that planning decisions recognise the need to secure, conserve and review (where possible), those natural resources vital to Perth's survival as a large urban centre; e.g. the primary groundwater source areas associated with public water supply.

2.1 CURRENT PLANNING FRAMEWORK

Within the area covered by the MRS, there are four basic zonings; urban, urban deferred, industrial, rural. Other land uses, e.g. regional open space, are identified. Zonings cannot be changed without going through a public announcement of the proposal because so many factors have to be taken into account when evaluating what could be termed "the most appropriate beneficial use or uses" for a piece of land.

Although itdoes not have any statutory backing, the Corridor Strategy has also provided a guideline for Perth's development form over the last 15 years.

In 1987 the SPC released the report "Planning For the Future of the Perth Metropolitan Region" for public comment. It is understood that many submissions were made on the proposed planning strategy and that it could be some months before a firm proposal is put up for adoption.

Currently there is a shortage of affordably priced land for housing in Perth, and planning authorities believe that more land must be rezoned urban very soon if the demand is not to exceed availability, thereby causing a price hike.

2.2 REZONING - THE FUNDAMENTAL ISSUE

As part of the formulation process and the dynamic implementation of the MRS, and also the dependent local authority town planning schemes, it has been necessary to recognise and resolve conflicts between existing and desired land use. The amount of "conflict free" land has rapidly reduced in recent years as Perth's urban structure has become more complex. Resolution of the planning dilemma of how to hold enough land to conserve a variety of important natural resources while providing sufficient land to meet the housing demand of a rapidly growing city has become the fundamental issue.

Fortuitously, as Perth was building up to a million population, the planning strategies adopted provided some protection indirectly for natural resources such as wetlands, groundwater and landscape features. With recent proposals for rezoning amendments, this is no longer the case and some conflict is occurring.

With such a large city, the planning conflicts do not only relate to natural resources of regional significance, They often embrace local features, which are only recognised as important by those people familiar within the locality, e.g. historic sites, small lakes, unique stands of bushland, the habitat of a rare animal.

If these "local requirements" are not integrated with the regional open space requirements, our Perth of the future is likely to become a monotonous continuum of unrelieved suburbs without any identity or differentiation. This aspect is of particular importance on the flatter parts of the coastal sand plain that are well away from the major river systems.

2.3 CONSERVATION OF NATURAL RESOURCES

Perth is fortunate in that there is still a representative cross-section of the various types of wetlands and related landforms available for conservation. However, not all the examples are on land under the control of an appropriate agency.

It has been estimated that Perth has already forsaken 75% of its original wetlands for development.

Similarly, because of its relative abundance and suitability for urbanisation, Perth has almost lost the opportunity to preserve representative stands of banksia woodland.

Therefore, it is most important that land planning strategies identify unique or favoured conservation areas at the start of the assessment process.

The TAG believes the conflicts being faced in proceeding with the Thomsons Lake rezoning proposal and with implementing the Beeliar Regional Park concept highlight the need to determine the natural resource priorities before rezoning is allowed to proceed.

The SPC, WA of WA, CALM and EPA have been working on natural resource policies that will assist planners, and the community, in determining the preferred beneficial land use. The WA of WA's recent publication "Land Planning and Groundwater Resource Protection Policy" and the EPA's "Draft Guidelines For Wetland Conservation in the Metropolitan Area" are examples. However, it is most important that the responsible agencies keep their data coming forward at a rate to match the implementation of the policies; e.g in the case of the examples above the WA of WA has not yet defined the boundary of the primary source area for the Jandakot Mound, and a number of endangered wetlands have still not been classified in terms of their importance.

In the case of the rezoning being examined here, it appears that two developers were able to complete the planning for their developments faster than the planning process could accommodate them. Unfortunately, unless government and other agencies declare their interest and highlight servicing, conservation or resource requirements early, the expectations of land owners and developers become quite high. Naturally, any late action or planning condition likely to prevent the achievement of their expectations is strongly resisted.

Another planning proposal that was brought to the TAG's attention was the Jandakot Botanical Metropolitan Park shown in Fig 69 of the SPC Report " Planning For the Future of the Perth Metropolitan Region". This linear park proposal, which is linked to the Beeliar Regional Park, can be catered for in the "Preferred Strategy" put forward in the Report. This form of land-use close to the centre of the Jandakot Mound appears to have some very long term benefits to the community.

Ad hoc development over the Jandakot Mound is likely to negate the opportunity for creating a botanical park. The TAG believes that the suggestion of a regionally significant botanical park located near the centre of the Mound has considerable merit, and therefore felt that any planning initiatives for releasing land as a matter of priority should allow for the botanical park.

2.4 WATER RESOURCE MANAGEMENT CONSIDERATIONS (STRATEGIES)

Contrary to popular belief, public water supplies are not the major users of groundwater on the Swan Coastal Plain. The environmental water demand is much greater. Furthermore, because the environment only has a limited tolerance to water level and quality variations, this demand is difficult to satisfy without an acceptable management strategy being worked out before urban development takes place.

The WA of WA is now required to undertake an environmental review before it can expand or develop a new groundwater source. It is currently preparing Public Environmental Report for the second stage of the Jandakot borefield, which involves a north-south line of bores running through the area submitted for rezoning (see Figure 2). The proposal has been public knowledge for many years and the WA of WA has progressively purchased the bore-sites.

It is important that the key criteria for the management of this public water supply demand is recognised and incorporated in any urban design strategy. If there are some environmental features such as wetlands, which have not been classified, the TAG considers that the urban development proponent must be required to engage a reputable consultant to carry out an assessment to standards laid down by EPA.

2.5 ARTERIAL DRAINAGE SCHEMES

Under the Metropolitan Water Authority Act 1982, the WA of WA is charged with ensuring arterial drainage schemes are compiled for the planning, managing, maintaining, financing, extending and improving of drainage services necessary to serve the metropolitan area.

The Act states that the WA of WA is required to prepare plans which show:

- drainage catchments;
- lakes, swamps, wetlands, watercourses and other features related to natural drainage;
- areas of existing, proposed or potential development;
- the existing drainage system - differentiating as to the kinds of drainage;
- the proposed drainage system - differentiating as to the proposed kinds of drainage and the persons or bodies to be liable for the provision and maintenance of that drainage; and
- land which, in the opinion of the Authority-

  (i) benefits from drainage; and

  (ii) contributes to the need for drainage.

- drainage areas and areas likely to be proclaimed as drainage areas.

Furthermore, the Arterial Drainage Scheme shall make provision for:

- arterial drains;
- main drains;
- drainage areas; and
- drainage courses

and may make provision for utilising the potential of the Scheme to conserve water, to re-charge aquifers and for the management of the natural environment.

In planning and implementing an Arterial Drainage Scheme, the WA of WA is required to consult with local councils and other bodies having responsibility for health, planning, roads, railways, conservation and environmental protection etc.

Naturally, the development of a drainage scheme is more important in some areas than others. Although the TAG understands some preparatory work had been done and drainage strategies formulated for management of extreme lake levels in the Beeliar wetland chain, it was difficult to understand why the WA of WA does not have a clearly documented arterial drainage plan for one of Perth's key water resource areas. The lack of such a plan appears to be incongruous with the way the WA of WA has highlighted to the Environmental Protection Authority and others that good land use planning is crucial over the Jandakot Mound, and that any planning must be integrated with sound water resource management practices.

2.6 LAND PLANNING DECISIONS AND THEIR LEGAL IMPLICATIONS

While town planning rezoning decisions in the past have not generally been the cause of legal claims for property damage or injury, recent floodings in the eastern states, radiation hazards around nuclear power plants and noxious gas emissions overseas, have now made land planning authorities more mindful of legal issues.

If a planning authority (say the SPC) allows development in a flood prone area contrary to expert advice, or residential development within a zone identified as having a high hazard risk to chlorine exposure, can the planning authority be sued in Western Australia?

Similarly, if a developer undertakes certain works to control the water table level, who is responsible if those works do not perform as predicted? When subsoil drains are more effective than expected, their excessive discharge can cause problems elsewhere. If they do not work nearly as well as predicted, development in low areas could experience water-logging problems, which may not be evident for five or more years.

Recent experience in Perth particularly as the result of flooding (eg Wright Brook and South Lakes) has shown that local authorities and State Government agencies, while they have not been legally liable to compensate residents, have had to step in and remedy the situation. This has been necessary both as far as the individual residents are concerned and in the resolving of local drainage problems. Unfortunately, the original developer generally cannot be made accountable.

This situation should not be allowed to continue, especially with the financial strain communities are facing today. It is preferable that liabilities in this respect between parties are determined when the land is being rezoned or subdivided.

The alternative is for a developer to accept a reduced lot yield or provide some form of financial security (eg by bank guarantee) to cover the cost of restoration and compensation should the prediction be wrong.

The TAG believes EPA should seek advice from the Crown Law Department and explore the possibility of the legal responsibilities of developers being defined within the planning process.

2.7 POLLUTION ISSUES

Good planning must acknowledge the interaction of the factors that are likely to influence the quality of lifestyle in new subdivisions. The EPA has endeavoured to facilitate this process through publications like Bulletin 79 (listing sources and causes of pollution, especially in wetlands), Bulletin 227 (guiding the developer and planner on how to appropriately address wetlands) and more recently the WA of WA guidelines for urbanisation over groundwater resources. The potential for pollution of both air, land and water resources can be greatly reduced by adopting appropriate land planning strategies.

The above documents should now be standard guidelines for developers and planners on the Swan Coastal Plain, to ensure that potential pollution issues arising from a proposed development can be identified and addressed at an early stage.

2.8 CO-ORDINATION OF INFRASTRUCTURE

Although it is not always a problem, the timely provision and co-ordination of services and other infrastructure is important, particularly to new localities. Integrated and detailed infrastructure planning should ensure a good marriage of structure plan, lot release and delivery of services. A developing community will then see its amenities grow and feel assured that its lifestyle will be sustained along with the natural environment.

The Beeliar Regional Park will be a major infrastructure amenity for the new and existing suburbs nearby.

The Beeliar Compensating Channel would also be a major infrastructure component, along with the Thomsons Lake main sewer. Add to these the requirements of a new area, roads, power, water, schools, public open space for active and passive recreation, there can be no doubt that close co-ordination between government agencies, local authorities, public and private developers will be vital, particularly as far as the success of the proposed drainage management plan is concerned.

3. THE BEELIAR WETLANDS

The TAG is mainly concerned with the wetlands affected by the Beeliar Channel proposal (ie from North Lake to Thomsons Lake). These wetlands are part of a wider planning study which has recently been undertaken by the Beeliar Regional Park Consultative Committee (BRPCC).

The history of and recommendations of the BRPCC are directly relevant to the wetlands that concern the TAG, and are detailed in the sections that follow.

3.1 THE BEELIAR REGIONAL PARK CONSULTATIVE COMMITTEE

3.1.1 HISTORICAL DEVELOPMENT OF THE BEELIAR REGIONAL PARK

Concern for the Beeliar wetlands was first expressed in 1976 in a report entitled "The Cockburn Wetlands-An Environmental Study" (Newman, 1976). This report emphasised the "exceptional qualities" of the eastern wetland chain and suggested that a "Beeliar National Park" be created to include all the wetlands from North Lake to Banganup Lake.

In 1983 the System 6 Report (EPA, 1983) recommended that the area designated M93 (North Lake to Wattleup Lake) be designated as a regional park to be managed by the National Parks Authority (now CALM) and that this area be reserved under the MRS for Parks and Recreation. In July 1986, the Government announced its intention to undertake a planning study to formulate proposals for the establishment of the Beeliar Regional Park, to include both the eastern and western chains of lakes in Cockburn (System 6 areas M91, M92, M93). A consultative committee was formed comprising CALM (Chair), EPA, SPC, MRD, WA of WA, Town of Kwinana, City of Cockburn and the Wetlands Conservation Society.

The main function of the BRPCC was to provide advice to the SPC during the process of its drafting of a planning study for the establishment of the Regional Park.

3.1.2 THE COMMITTEE'S REPORT AND ITS CURRENT STATUS

The final draft of the planning study is expected to be available for submission to Government in early 1989, with a proposal for release for a period of 2 - 3 months of public review.

The main findings of the study, relate to the importance of the wetlands, the current and possible uses and the responsibility for management of the Park. Quotation marks are used where sentences have been taken directly from a draft version of the planning study.

Importance of the Wetlands

The planning study notes that "the wetlands of Perth have been disappearing over many years for a number of reasons", and that "wetlands are particularly susceptible to changes in their surrounds". "Drainage into wetlands causes changes to water quality, and stormwater run-off can cause variations in water levels which in turn affects both the flora and fauna dependent on a particular wetland."

"Pollution through, for example, nutrient-enriched run-off leads to eutrophication of wetlands and their consequent degradation."

"The wetlands within the Beeliar Regional Park are by no means pristine but nevertheless are considered to form one of the most important series of lakes and wetlands remaining within the Metropolitan Region".

"Much of the proposed Park has high conservation, recreational and aesthetic value."

Current and possible uses

"The Park offers great diversity, which is reflected in the proposed land uses; these range from traditional active recreation pursuits, through passive areas set aside for walking and picnics, to those parts of the area considered most sensitive, where opportunities to observe nature undisturbed can be provided."

"The basis of a Regional Park is to encourage - as far as possible -public use, and to cater for recreation, conservation and landscape protection."

Future management organisation

The Study proposes that "the Park will be managed jointly by the City of Cockburn, the Town of Kwinana and the Department of Conservation and Land Management" and "Management will be co-ordinated by Department of Conservation and Land Management and assisted by an Advisory Committee comprising selected Government Departments, the Local Authorities and interest groups".

"The management, planning and therefore administration of the Beeliar Regional Park will allow individuals and special interest groups from the community to participate in the decision making process."

The study provides broad guidelines for the subsequent formulation of an overall management plan by categorizing wetland areas (and adjoining vegetation) into the types of uses considered most appropriate for each area (eg recreation, leisure and sports etc). These are detailed in Section 3.2.2. Formulation of a detailed Management Plan will be the responsibility of the Department of Conservation and Land Management in consultation with the authorities noted above and the public.

"In summary, the Beeliar Regional Park will recognise the public values in the retention of this area as well as seeking to protect the recognised wildlife conservation values of the area".

3.2 WETLAND MANAGEMENT CATEGORIES

Two documents, the EPA's "Guidelines for Wetland Conservation in the Perth Metropolitan Area" (Bulletin 227) and the BRPCC's planning study, provided the TAG with broad management categories for wetlands. However, the TAG determined that there should be a re-evaluation of the Beeliar Wetlands according to the revised version of Bulletin 227 (Bulletin 374) which was presented to the EPA in early January and due to be published in March 1989. At the time of publishing this report, the actual names (but not the management objectives) used for each category were under review. There is no perceived conflict with the categories determined by either Bulletin 374 or the BRPCC's planning study.

3.2.1 ENVIRONMENTAL PROTECTION AUTHORITY "GUIDELINES" EVALUATION

Bulletin 374 places wetlands into one of five broad management categories by using a questionnaire which scores the "naturalness" and "human use" of the wetland. The questionnaire has been designed to determine these values for every wetland.

The questionnaire provides a "snapshot" assessment of each wetland's current condition. The resulting management categories do not reflect the rehabilitation potential afforded by the wetland's current status and management program. Active management, rehabilitation, or lack of management can change the assessment and subsequent management strategy.

Where the wetland questionnaire resulted in a score that placed the wetland close to another category grouping, this group is indicated in brackets to the right of the category determined.

A set of supplementary questions are provided in Bulletin 374 to highlight other possibly important aspects of the wetland, such as the presence of rare species. Some of the supplementary questions influence the determination of the management categories.

The guidelines place wetlands into one of five management categories, viz:

High Priority Conservation Areas (Category H for High Priority Areas)

These wetlands possess high natural and/or human use attributes, and therefore their management priorities are:

- active management to maintain and enhance the wetland attributes, particularly natural attributes;

- this category is recognised as having the highest priority for the establishment and implementation as regional park wetlands; and

- where absent, active management should be put in place as a matter of highest priority.

Active management is seen as meaning the degree of management currently attributed to National Parks by the Department of Conservation and Land Management.

Wetlands Whose Primary Function is Conservation (CATEGORY C for Conservation)

These wetlands possess relatively intact natural systems and their management priority is:

- to maintain and enhance the natural attributes and functions.

Wetlands Suitable for Conservation and Recreation (CATEGORY O Open space for conservation and recreation)

Many of these wetlands have been highly modified but are considered to play important roles in their urban and/or rural settings. Their management priority is:

- to maintain and enhance the existing human use attributes whilst maintaining and enhancing natural attributes and functions.

Wetlands Suitable for Conservation, Recreation and Development (CATEGORY E for Environmentally Sensitive Development)

Many of these wetlands have been significantly modified and/or do not have clearly recognised roles in their urban or rural settings. Some of the wetlands in this group will be the focus for controversy if uncontrolled developments begin to impinge upon them.

Therefore their management priority is to maintain the existing functions. Developments likely to impinge upon them should be subject to Environmental Impact Assessment.

Proponents of developments which would affect wetlands in this group will be required to carry out an environmental review. In the event of the wetland being shown to have a definable function, the development may be recommended for approval provided:

(a) the wetland function is retained within the development, or

(b) an equivalent area of wetland of a similar type is generated or rehabilitated to fulfil equivalent functions.

Wetland with Potential for Multiple Use (CATEGORY M for Multiple Use)

Wetlands in this category have few remaining natural attributes being significantly degraded and possess limited human use attributes.

The management priority for these wetlands should be seen in the context of catchment and land use planning, especially drainage, nutrient cycling, summer pastures, and residual spring waterbird habitat.

Many of the wetlands in this category are vulnerable to impacts of intensified land use, drainage, road construction and expansion of service corridors. This group includes many wetlands which will be a focus for controversy if developments begin to impinge upon them.

Table 1 and Figure 3 show the management categories determined from the revised guidelines for the East Beeliar wetlands.

Table 1. Revised Management Categories: Beeliar wetlands.

LAKE	CATEGORY
North Lake	O(E)
Lower Swamp	E(O)
Roe Swamp	E
Bibra Lake	O(C)
South Lake	E
Little Rush Lake	E
Yangebup Lake	O(E)
Kogolup North	E*
Kogolup (Whole Lake)	C(E)
Kogolup South	C(E)
Thomsons Lake	C(H)
Hird Road Swamp	E(M)
Branch Circus Swamp	E
Copulup Swamp	M
Banganup Swamp	C

* Kogalup North will be category C when the private property is aquired and agricultural activities cease.

3.2.2 PLANNING STUDY CATEGORIES

The proposed land uses detailed in the BRPCC's planning study range from promoting public access into the park (eg Bibra Lake West) to tight restrictions on entry (eg Banganup Lake Marsupial Research Station). Further detailed assessment of the designated uses is to be addressed by the future management organisation.

The categories chosen by the planning study are as follows:

Recreation, leisure and sports	North Lake (east of Bibra Drive) Bibra Lake (west and south) Lake Coogee (west and south) Mt Brown area (existing activities adjacent to present Cockburn Road)

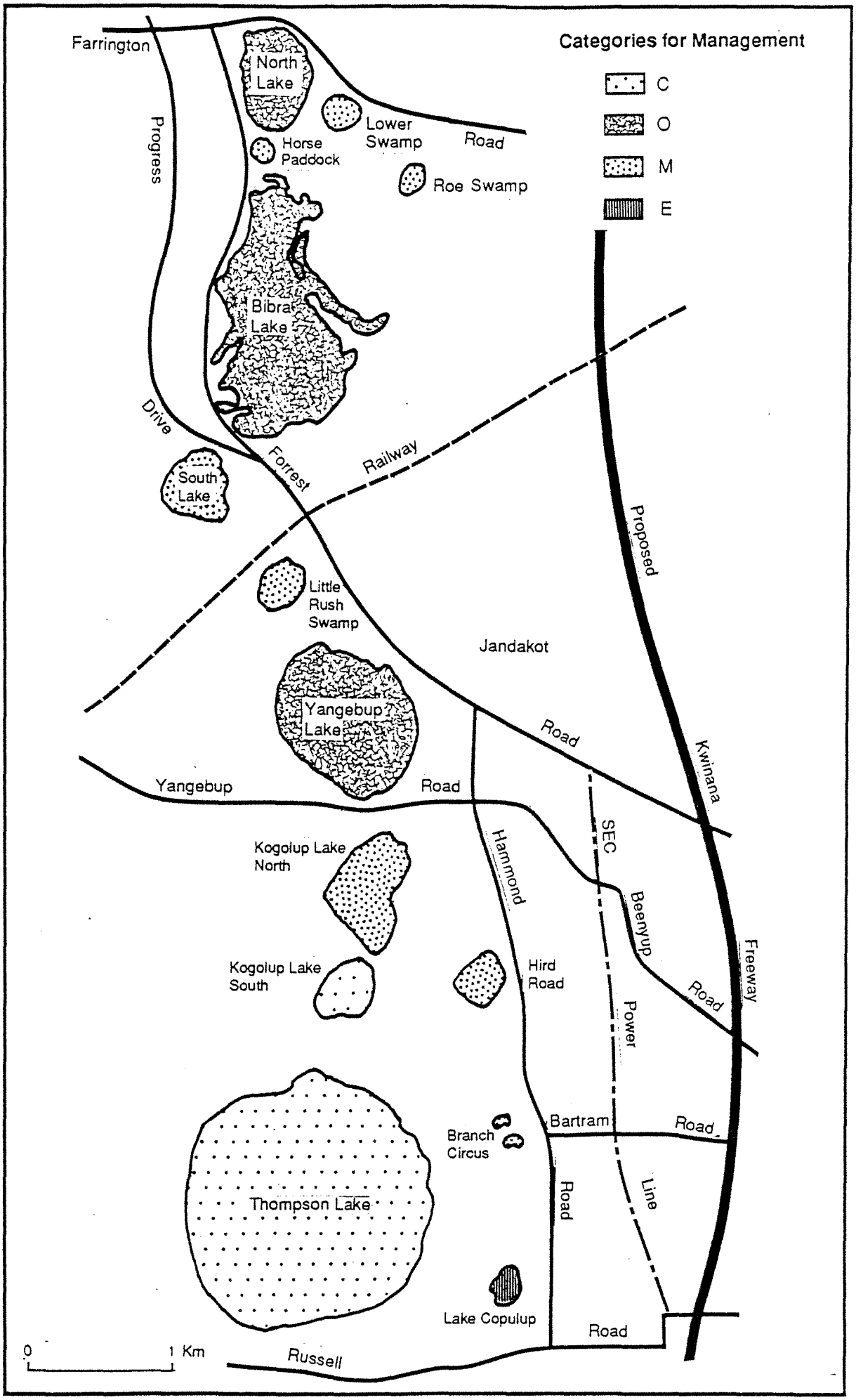


Figure 3. Beeliar Wetlands - EPA Categories for Management.

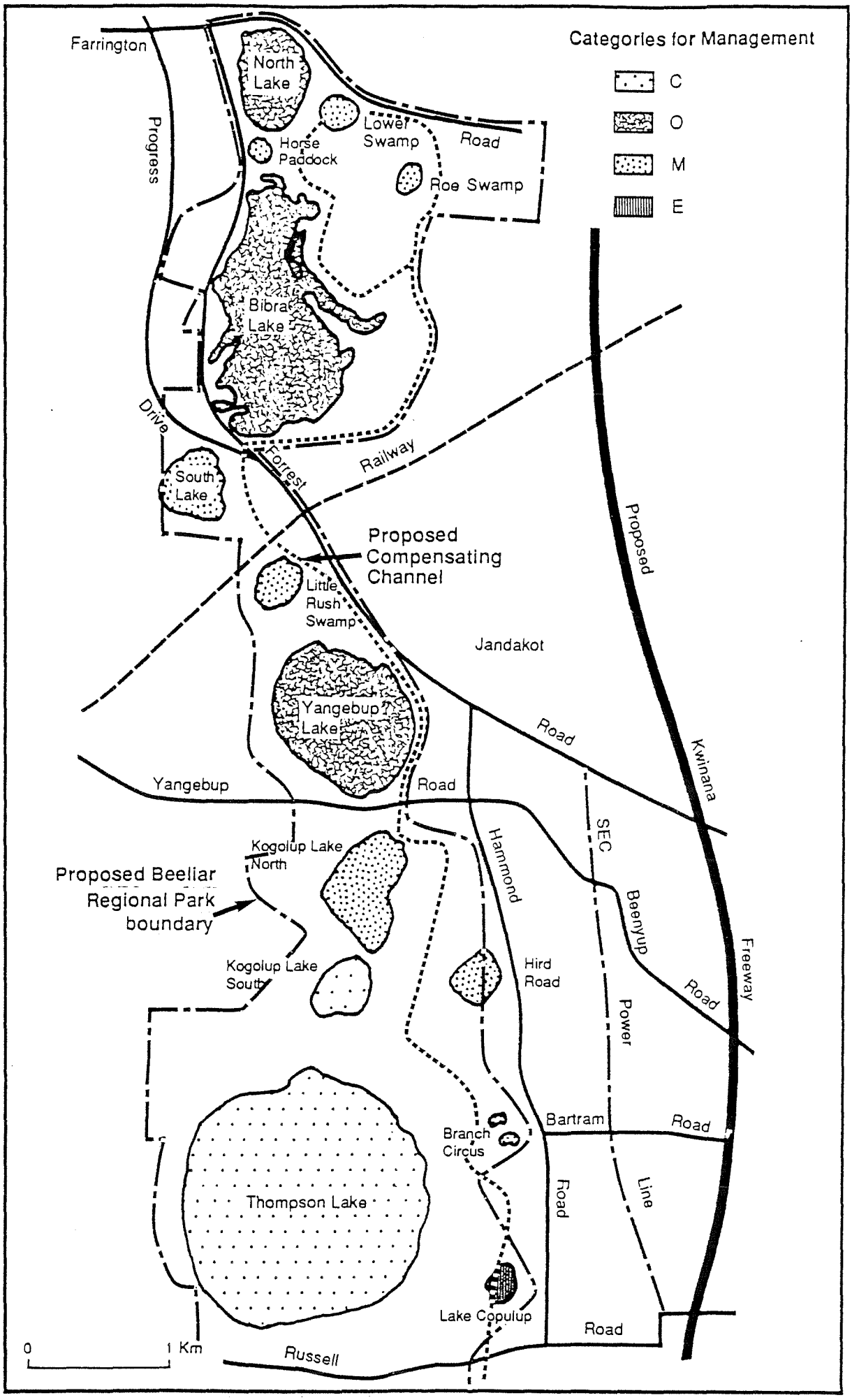


Figure 4. Proposed Beeliar Regional Park Boundary and Land Use Categories.

Recreation and leisure	North Lake (western shore) Bibra Lake (north east) Yangebup Lake (north, west and south shores) Manning Lake Market Garden Swamps (1 and 2 as part of urban development; 3 as part of Lake Coogee surrounds) Lake Coogee Mt Brown Lake
Natural Environment Uses	Bibra Lake (east and south east) South Lake Kogolup Lake Thomsons Lake The Spectacles (east, north east and south west) Brownman Swamp
Natural Environment Education	Banganup Lake
Natural Environment - Wildlife Management	North Lake (balance) Bibra Lake (part of eastern shore) Little Rush Lake Kogolup Lake Thomsons Lake Wattleup Lake The Spectacles (balance) Long Swamp
Special Management Area Pollution Control	Yangebup Lake (east)

Figure 4 shows the proposed boundary of the beeliar Regional Park.

3.3 WILDLIFE VALUES

The wetlands of the proposed Beeliar Regional Park and their surrounds provide a wide range of habitats and are of local, regional and state importance in terms of wildlife conservation. Furthermore, several species of migratory birds which are protected by International Treaties use areas within the proposed Regional Park.

The chain also provides a corridor for fauna movement, particularly bird species.

The full extent of the conservation value of the area east of Thomsons Lake which is the subject of the rezoning proposal has not been assessed but indications are that the declared rare Freckled Duck (Stictonetta naevosa) breeds in wetlands in this locale.

Apart from the waterbird values outlined below the surrounding bush areas of the lake chain provide a refuge and nesting opportunity for a wide range of bushland bird species.

3.3.1 RARE SPECIES

In the North Lake/Lower Swamp/Roe Swamp Complex, the lined skink (Lerista lineata) which is on the endangered species list and the Turtle Frog

(Myobatrachus gouldi) which is a particularly unusual species are present. In Roe Swamp an unidentified Melaleuca species or natural hybrid has been found (Students of Environmental Management 1986).

The surrounds of both Thomsons Lake and Kogolup support populations of the previously declared rare plant Hackett's hop bush (Dodonaea hackettiana)

3.3.2 WATERBIRDS

The EPA's Bulletin 374 has a questionnaire on waterbirds. Its purpose is to ensure that questionnaire users can interpret the value of waterbird data. The value of the waterbirds questionnaire score in the Perth Metropolitan area is still undetermined.

The value of each wetland to waterbirds, where known, is described below. This information was generously supplied in discussions with the RAOU.

North Lake:

Appears to be important for breeding of ducks.

Bibra Lake:

Exceptionally large numbers of Hoary-headed Grebe, (Poliocephalus poliocephalus) possibly being the largest number in the State. High diversity of species.

South Lake and Little Rush Lake:

More work required.

Yangebup Lake:

The largest numbers of Pink-eared Ducks (Malacorhynchus membranaceus) and Blue-billed Ducks (Oxyura australis) of any wetland in the south west have been recorded.

Kogolup Lake:

More studies are required, however, this wetland shows a high potential for breeding with moderately high number of species and breeding species. The scrub thickets in the south east corner are not found elsewhere in the chain and provide a potential breeding area for the Little Bittern (Ixobrychus minutus).

Thomsons Lake:

In an RAOU survey of wetlands of the south west of Australia this lake ranked as follows:

4th highest in the number of species
10th highest in the number of species breeding
2nd highest in the number of species for which the habitat is important
6th highest in the total number of waterbirds recorded.

This wetland shows a very high diversity of bird species, is important for breeding, and probably satisfies the criteria of a wetland of international importance.

Substantial numbers of migratory waders are regularly recorded including rare species and the wetland is a remnant breeding area for Marsh Harriers (Circus aeruginosus)and Australasian Bitterns (Botaurus poiciboptilus) in the metropolitan area.

3.4 SOCIAL VALUES

The presence and protection of these wetlands provides a unique opportunity for interaction with a range of 'types' of natural environments in an increasingly urban situation. This is reflected in the Beeliar Regional Park Planning Study.

These Beeliar wetlands are of existing and potentially high future value to the local and wider community.

The planned complimentary link of the richly diverse lake types in the Beeliar eastern chain, having a large variety of fauna and flora would contribute strongly to the region's long term amenity and environmental stability.

The lakes system is already viewed as an asset to lifestyle by local residents and the proposed Regional Park development having adequate wetlands protection, with selected human recreation areas, will greatly enhance adjacent residential areas. Such enhancement will be reflected through market demand for property in the area, real estate values, rates and land tax collections and improved 'quality of life'.

The TAG believes the benefits, which may emerge from the realisation of the full potential of the Beeliar Regional Park, will include educational, scientific and economic rewards.

When the Perth region is more intensely populated, the presence of the Beeliar Regional Park should be positive to attracting new business and escalated real estate development around its periphery, generating a range of community employment and other benefits.

The System Six Study clearly identifies that these areas have a reasonable significance in servicing the wider community.

3.5 PROTECTION AND MANAGEMENT

3.5.1 MANAGEMENT OF THE BEELIAR REGIONAL PARK

By way of example the following problems are affecting or are likely to affect one or more of the wetlands:

- Weed invasion.
- Drains.
- Fire.
- Recreational pressures.
- Horse grazing or riding.
- High water levels.
- Eutrophication.
- Heavy metals.
- Road alignments.
- Nuisance fauna: midges, rabbits.
- Previous use of areas for sanitary landfill.
- Inappropriate adjoining land uses.

Assuming that the recommendations of the Beeliar Regional Park Consultative Committee are accepted by Government, the TAG is confident that the future management organisation will address and monitor environmental issues.

The TAG has prepared interim water level and water quality criteria for the wetlands affected by the Beeliar Channel Proposal. The TAG assumes that these criteria will be examined by the Beeliar Regional Park management authority and modified as more reliable and accurate information becomes available.

3.5.2 IMPORTANCE OF WATER LEVELS AND WATER QUALITY

Water levels and water quality have direct impacts on wetlands. A change in the water regime can result in the death of wetland vegetation. For example, paperbarks will die if increased water levels result in them being permanently inundated and, if water levels are lowered, rushes such as Typha may colonize areas that become shallower

A deterioration in water quality can result in algal blooms which can cause the death of many aquatic fauna, an increase in midge problems, foul smelling water and the death of submerged vegetation.

3.5.2.1 Current Situation

The TAG notes with some concern that hydrographs for all the wetlands considered in this report, have shown increasing maximum and minimum water levels since 1980 (see Figures 5 and 6 to compare rainfall with hydrographs).

In January 1989 the water in North Lake was still flooding the picnic area and paths, at Bibra and Little Rush Lakes the fringing paperbarks were still inundated with at least 40 cm of water and Yangebup Lake was only a few centimetres below the lowest point on Yangebup Road. The high levels have occurred despite below average rainfall for six of the last eight years (Figure 6). The 1988 rainfall was 912 mm, only 42 mm above average. It appears that these lakes are experiencing an initial rise of water level because of increased runoff from new and existing urbanised areas.

The TAG believes that adverse changes to the wetlands and flooding of nearby homes particularly at South Lakes will occur unless prompt action is taken to remedy the current situation (refer to section 3.6.1 regarding Yangebup Lake).

Water quality in most of the wetlands under consideration is poor and will get worse unless appropriate action is taken. Water quality notes for each wetland are given below.

North Lake:

> Subject to blooms of blue-green algae in summer The results of a recent study are being implemented to reduce nutrient inflow from Murdoch Drain which contributes about 70% of the lakes annual phosphorus load. Nutrient inflow from Kardinya drain in 1987 was 25 kg of phosphorus.

Lower Swamp:

> High tannin (gilvin) levels prevent algal blooms, but large areas of duckweed are present, indicating high nutrient inputs from Murdoch drain.

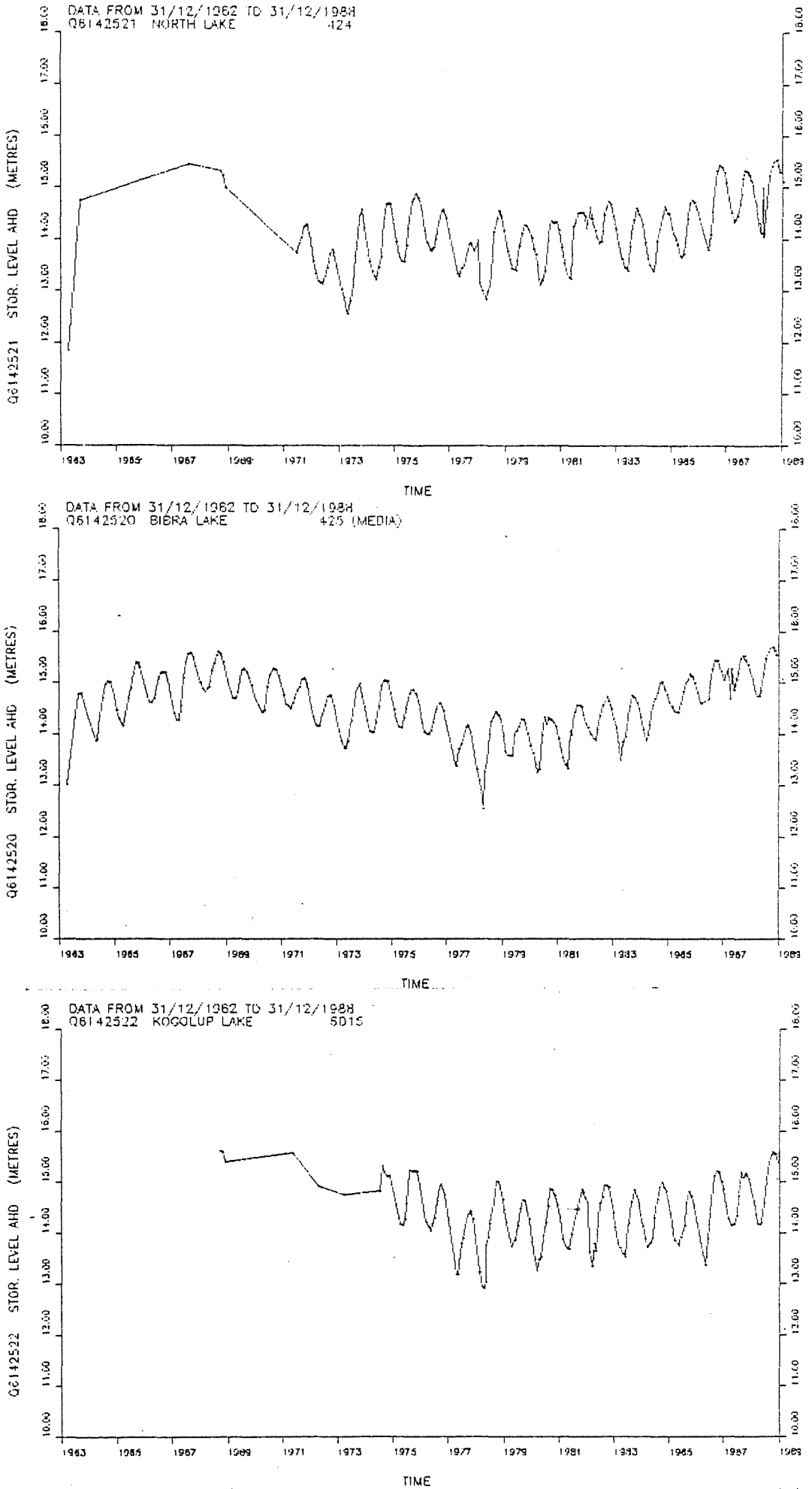


Figure 5. Hydrographs

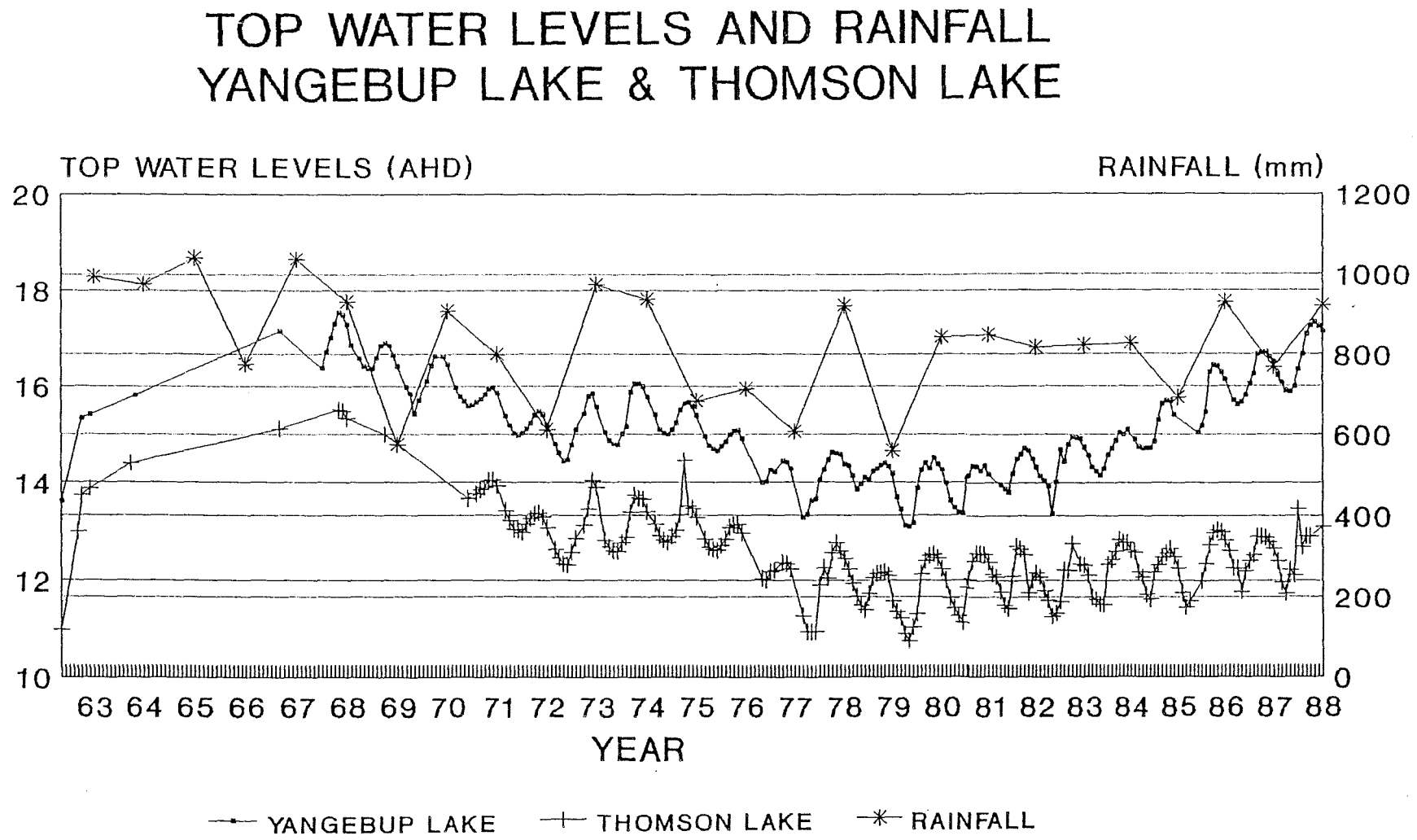


Figure 6. Hydrographs and Rainfall

Bibra Lake:

Subject to blooms of blue-green algae in summer. Landfill sites, stormwater and adjacent parkland may contribute significant amounts of nutrients. Deep sediments indicate that this lake was probably naturally eutrophic.

South Lake:

High tannin levels prevent algal blooms, but large areas of Azolla cover open water areas. No drainage input, but adjacent land uses (grazing and horses) may contribute nutrients.

Little Rush Lake:

No nutrient problems reported or observed in January 1989 survey. High tannin levels noted. Nutrient input from Yangebup estate drainage (19 ha) is probably within the lake's assimilative capacity.

Yangebup Lake:

Water quality in Yangebup is poor compared with the other lakes and algal blooms occur each summer. The lake has an historical arsenic pollution problem from wool scouring effluent. Nutrients enter the lake from the woolscourers on the eastern side of the lake, and from the South Lakes urban estate which drains into the lake. Drainage waters from the suburb of Yangebup do not flow into this lake. Nutrient input from the South Lakes estate alone would probably exceed the lake's assimilative capacity.

Kogolup Lake:

This lake has high tannin levels that prevent algal blooms. The January 1989 survey reported no drainage input into the lake, but a small agricultural drain flows intermittently into Lake Kololup and agricultural uses occur in the northern half of the catchment which could contribute nutrients to the Lake.

Thomsons Lake:

Thomsons Lake currently receives water and nutrients from a rural drainage catchment of about 1600 ha. The limited monitoring to date indicates that water quality problems can be expected to occur if the current rate of nutrient input continues.

3.5.2.2 Effects of Urban and Rural Development

In their natural state Perth's wetlands are expressions of the groundwater table that, by virtue of their position in the landscape, act as nutrient sinks. The water in Perth's wetlands before European settlement was generally nutrient poor, but some lakes such as Bibra Lake may have experienced periodic high nutrient concentrations and algal blooms when nutrients were released from the sediments. Bibra Lake has peaty sediments more than 2m thick in places.

The implementation of drainage schemes and large scale clearing for urban or rural development has often resulted in changed water regimes and a deterioration of water quality in Perth's wetlands.

Large scale clearing of vegetation causes a rise in the shallow water table which often has detrimental effects on the wetland.

Surface runoff and drainage rates for rural and urban areas should be determined. At Kardinya a stormwater flow of 60.2 x 10^3 m^3 was recorded from a 58 ha catchment from 1 April 1987 to 31 March 1988, a year of low rainfall.

Only two studies; the Peel Harvey Study (Kinhill Engineers, 1988) and The North Lake Study (Bayley, in prep), provide information on nutrient losses from urban and rural areas on the Swan Coastal Plain.

Table 2 below indicates the phosphorus and nitrogen export rate per hectare of rural or urban land. These figures are the best available but should be used with caution. The Peel-Harvey study found a positive correlation between drainage density (metres of drainage channal per hectare of catchment) and nutrient export rates in runoff (kg ha^{-1} yr^{-1}). The North Lake Study was done in 1987 which was a year of low rainfall. The Peel-Harvey Study noted that the phosphorus export rate (kg ha^{-1}) increased with rainfall.

Table 2. Measured nutrient export rates for urban and rural areas.

SITE	NUTRIENT LOAD kg ha^{-1} yr^{-1}	CATCHMENT AREA (ha)	% CLEARED
Peel-Harvey deep grey sands	4.5 P	5200	33
Murdoch vet farm-irrigated rural	5.4 P	48	43
" " " " "	9.9 N	48	43
Kardinya drain - sewered urban	0.43 P	58	100
" " " " "	2.2 N	58	100

3.6. INTERIM WATER LEVEL AND WATER QUALITY CRITERIA

3.6.1 INTERIM WATER LEVEL CRITERIA

In order to protect the values of the Beeliar wetlands and ensure that no flooding occurs, permissible maximum water levels have been suggested. These water level criteria will be subject to modification as more accurate data become available. Where no existing or suggested water criteria exist the TAG have determined maximum water levels on the basis of wetland cross sections and hydrographs from Bulletin 266 (Arnold 1989). This information is presented in Table 3 below.

Table 3. Recommended Interim maximum water levels as determined by the TAG (Water levels in metres AHD).

WETLAND	MAXIMUM LEVEL
North Lake	14.9 (McDougal 1989)
Bibra Lake	15.0
South Lake	13.8
Little Rush Lake	15.9
Yangebup Lake	16.5 - and see next paragraph
Kogolup Lake	14.8
Thomsons Lake	Refer to Table 4

The Management proposal for Yangebup Lake (Students of N319 Environmental Management, 1988) recommended that the Water Authority should ensure that the water level of Yangebup Lake is maintained between 13.9 m and 17 m AHD with the following constraints:

(i) The lake level must not exceed 17 m AHD for more than 3 months in any 12 month period; and

(ii) The lake is allowed to follow its natural seasonal fluctuations within these limits.

However, The Water Authority sugests a maximum of 16.5 m AHD be adopted. When the near record lake levels of 17.5 AHD was recorded in 1988, the water table level in Sandpiper Swamp just west of Yangebup was also rising rapidly. It is important that should the maximum level in Yangebup be maintained for any length of time, that it does not cause flooding of the public open space (ground level 14 m AHD) and existing houses in the vicinity of the Swamp. Furthermore 16.5 m AHD should permit reliable operation of the subsoil drainage system for development to the eastern side of the Lake.

CALM has prepared water level criteria for Thomsons Lake and these are presented in Table 4.

Table 4. CALM Interim Water Level Criteria for Thomsons Lake.

	WINTER/SPRING MAX	SUMMER/AUTUMN MIN
Wet Years (Wettest 10%)	14.3	12.8 (April)
Medium Years (80% of Years)	13.5	12.3 (Dry April)
Dry Years (driest 10%)	12.4	Dry by January

The occasional drying out of the wetlands is believed to help bind phosphorous into the sediment and improve water quality (Davis 1987). Although this finding has been disputed (O'Brien, 1988) the TAG believes it may be appropriate to pump out the wetlands, to allow them to dry on an occasional basis or to enable removal of sediments.

3.6.2. Interim Water Quality Criteria

CALM has set water quality criteria for a range of parameters as general guidelines for wetlands in the Metropolitan Region.

The TAG believes these should be adopted as interim criteria and that the management body proposed for the Beeliar Regional Park should give further consideration to water quality criteria. The water quality criteria set by the CALM appear in Table 5 below.

Table 5. CALM Metropolitan Water Quality Criteria.

pH	:	7 to 9
Salinity	:	< 1.5 ppt
Dissolved O_2	:	≥ 5 mg l^{-1} (mixed conditions). No limits where stratification occurs.
Stratification	:	Summer stratification acceptable provided water does not become nutrient enriched beyond the criteria set.
Turbidity	:	< 25 Jackson Turbidity Units.
Nutrients	:	Total P not to consistently exceed 100 ug l^{-1}
		Chlorophyll A < 100 ug l^{-1} (max)
		Total N < 10 000 ug l^{-1} (max)
Pesticides	:	Chlordane < 0.1 ug l^{-1} (in water)
		DDT < 0.01 " " "
		Dieldrin < 0.03 " " "
		Heptachlor < 0.01 " " "
		Chlorpyrifos < 0.1 " " "
		Temephos < 1 " " "
Oil and Petro-chemicals	:	No spills leaving surface film.
Other	:	No floating debris other than that which occurs naturally.

Phosphorus

The input of phosphorus to wetlands is a critical determinant of algal growth and water quality. Therefore the TAG has provided further detailed criteria for each wetland.

According to Vollenwieders model (Reckhow 1981) the maximum permissible areal loading to ensure wetlands do not become eutrophic is 0.2 g m^{-2} yr^{-1} of P. This areal loading figure holds true for a wide range of water loadings (1 to 10 m yr^{-1}).

The TAG notes with some concern that the South Jandakot Development Drainage Management Plan used an areal loading figure of 0.35 g m^{-2} yr^{-1} of P for its calculations.

Using the maximum permissible phosphorus loadings based on an areal loading of 0.2 g m^{-2} for each lake, the maximum permissible volume of storm water input at various flow weighted mean concentrations has been calculated. The calculations assume that one third of the maximum permissible phosphorus

Load will reach the wetlands through groundwater inflow. Table Six presents the results of the calculations and a sample calculation is provided for North Lake.

able 6. Maximum permissible phosphorus loadings in the main Beeliar wetlands.

WETLAND	LAKE SURFACE AREA (ha)	MAX P LOADING* kg yr^{-1}	MAXIMUM PERMISSIBLE SURFACE WATER INFLOW OOO m^3 AT FLOW WEIGHTED MEAN CONCENTRATIONS mg l^{-1} INDICATED			RECOMMENDED INTERIM MAX WATER LEVELS AS DETERMINED BY TAG (TABLE 3)	LAKE VOLUME AT RECOMMENDED WATER LEVELS 1000 m 3 (From Graphs)
			0.2mg l^{-1}P	0.4mg l^{-1}P	0.6mg l^{-1}P		
orth Lake	50	100	333	166	111	14.9	500
ower Swamp	12	24	80	40	26		
e Swamp	5	10	33	17	11		
rse Paddock	3.4	7	226	113	75		
bra Lake	148	296	986	493	328	15.0	1470
uth Lake	23	46	153	77	51	13.8	
ttle Rush Lake	9	18	60	30	20	15.9	
ngebup Lake	78	156	520	260	173	16.5	2050
golup Lake	44	88	293	146	97	14.8	350
omsons Lake	253	506	1686	843	561		

urface and groundwater inflow.

Sample Calculation 1; North Lake

1. For a water loading of between 1 - 10 m yr^{-1}, the maximum permissible phosphorus loading is 0.2 g m^{-2} yr^{-1} to prevent the wetlands becoming eutrophic (Reckhow 1981). Although accurate water balances are not available for the wetlands, the annual water loading range is believed to be between 1-5 m yr^{-1}.

2. Calculation of Maximum Permissible P loading

   Lake surface Area = 50 x 10^4 m^2

   Maximum permissible phosphorous loading = 0.2 g m^{-2} yr^{-1}

   > Max P input per year = 50 x 10^4 x 0.2. g yr^{-1}
   = 100 x 10^3 g yr^{-1} = 100 Kg yr^{-1}

3. Calculation of Permissible Volume on the Basis of Flow Weighted Mean

   Assume Flow Weighted Mean Concentration = 0.6 mg l^{-1} P

   = 0.6 x 10^{-3} x 10^3 g m^{-3} P

   = 0.6 g m^{-3} P

Assume one-third of maximum permissible phosphorus loading is contributed from groundwater flows. Therefore:

Maximum Permissible Surface Inflowing P = 66 Kg

Therefore Maximum Volume of surface inflow (m^3) @ 0.6 mg l^{-1} =

$$= \frac{66 \times 10^3 \text{ g}}{0.6 \text{ g m}^{-3}}$$

$$= 111 \text{ m}^3$$

These results have not been related to the wetlands ability to absorb these volumes of water.

4. PROPOSED DRAINAGE SCHEME AND EVALUATION

An important aspect in the urban development proposal is the construction of an arterial drainage system which includes a compensating channel, and the formulation and implementation of a drainage management plan. The drainage management plan should include strategies for groundwater recharge at appropriate locations.

Groundwater abstraction for public and private use can be integrated with a drainage management plan. However, compared to the peak flows generated by a significant storm, the pumping rates attainable by the bores linked to the public supply are quite low. Furthermore, due to ground conditions it may be many weeks before the water table over the wide area responds to any pumping initiative. Therefore, irrespective of the economic argument of whether or not dam storages should be used in preference to groundwater sources during winter, the operation of a public water supply borefield cannot be considered as an acceptable "drainage" strategy for coping with extreme rainfall events within the proposed South Jandakot urban development area.

4.1 DRAINAGE REQUIREMENTS

The drainage system within the development area should:-

(a) convey unwanted water (surface run-off and groundwater) away from urban areas to other localities where it can either be stored, exported for future reuse, or discharged to waste;

(b) control the water-table so that it does not exceed acceptable levels for urbanisation as determined by planning authorities; and

(c) safeguard buildings from inundation following extreme rainfall events.

The water collected in the drainage system may be unwanted because:-

(i) the quantity available is surplus to requirements and the systems storages are full; and/or

(ii) the quality is unacceptable for use elsewhere in the system.

In satisfying the above conditions, it may not be possible to sustain some existing environmental features, particularly wetland and dampland habitats.

Therefore, it is paramount that the environmentally important features that are to be retained and protected are identified, and their survival criteria for water level and quality determined before the design of the drainage system is finalised.

With these parameters defined, a system can then be designed that will sustain the environmentally significant features and cater for development andhousing on the balance of the subject area.

An independent evaluation and classification of existing wetlands and damplands was not arranged by the proponent. It is understood that a study was undertaken on behalf of Gold Estates. However, only a draft report was prepared and the results have not been made public.

Therefore, in order to assess the drainage proposal, the TAG had to make its own preliminary assessment of the wetlands in the proposed Beeliar Regional Park. It then adopted criteria for any wetlands with a classification rating based on EPA Bulletin 374 that warranted conservation consideration.

The classification of the wetlands and the selection of those worthy of conservation has been discussed in Chapter 3. Water level variation tolerances and water quality criteria were established for the selected wetlands.

The key question then became: "Did the proposed drainage system have sufficient flexibility to maintain the selected wetlands in their present condition or better while protecting the new urban area from flooding?"

4.2 DESIGN OF THE DRAINAGE SYSTEM

Because the TAG had some difficulty correlating information in the reports and other documentation available, it held discussions with G B Hill and Partners and Sinclair Knight and Partners, the engineering consultants. They provided a written response to TAG's questions. (Refer Appendix 1)

The principles upon which the design of the proposed drainage system of the area is based are:

1. a gravity operated system within the urban area and any surplus water to be exported out of the Beeliar wetlands by pumping;

2. the sustainable yield of the Jandakot water resource is to be maintained or improved;

3. use existing drains (drainage routes) as far as practical;

4. installed drainage, including subsoil drains, to limit groundwater-table rises to the summer water-table profile;

5. drainage water recharge basins and reverse flow subsoil drainage to be incorporated in the system;

6. arterial drainage flows to pass through compensating recharge basins to attenuate peak flow rates and retard flows to settle sediment;

7. to reduce nutrient concentrations all drainage flows to be held in buffer basins prior to discharge into main drainage channel;

8. water level control to meet CALM criteria for selected wetlands. (Only criteria available at present from CALM is for Thomsons Lake);

9. urban drainage design is to be based on the one in 5 year storm event;

10. compensating basin design to be based on the one in 10 year storm event;

11. water from storm events up to one in 100 year flood occurrence can back up on the system providing there is no flooding of any residential lots;

12. the drainage outlet to the area to incorporate the proposed Beeliar Channel to provide a means of passing water around Thomsons and Kogolup Lakes;

13. either Yangebup or North Kogolup Lakes or both together can be used as a buffer storage;

14. unwanted water will have to be discharged to waste in Cockburn Sound on some occasions if there is no groundwater recharge opportunity available; and

15. design is to be according to the Institution of Engineers "Australian Rainfall and Runoff 1987" and Australian Road Research Board publication "Storm Drainage in Small Urban Catchments".

The drainage catchments which naturally discharge into lakes in the Beeliar Park are shown in Figure 7 while Figure 2 shows the layout of the proposed drainage system along with the key components and their functions. Some peak flow rates are also quoted.

The TAG feels that these principles are acceptable except for number 13 and that environmental protection or water quality standards are not specifically addressed.

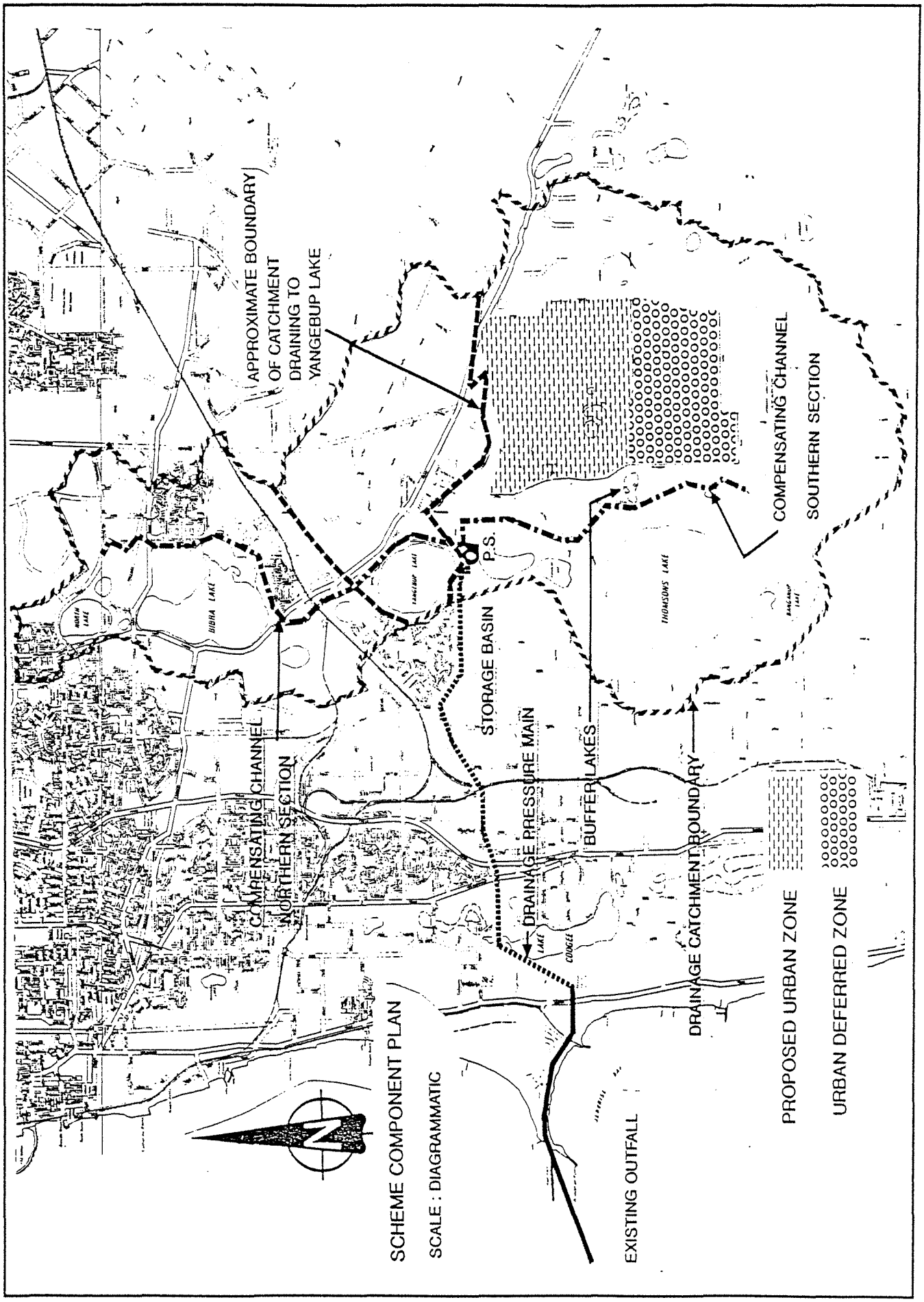


Figure 7. Drainage Catchment Boundaries.

4.3 OPERATING STRATEGIES

While it recognised that the drainage system had to be capable of handling extreme events, the TAG felt that it was the impact of the more common storm and rainfall events on the system which may be more important to the wetlands in the long run. This was particularly the case with nutrient transport.

The TAG was advised by the consulting engineers for the proponent that based on the annual rainfall records available, the following total annual drainage outflows would have occurred:

- Wettest year 5.78 Million cubic metres
- Average year 3.45 Million cubic metres
- Driest year 1.98 Million cubic metres

The TAG believes these figures suggest a higher degree of accuracy than is actually the case.

It is interesting to compare these annual outflows with the 3 million cubic metres of groundwater which the Water Authority currently pumps out of the Jandakot Public Water Supply Area.

The rate at which unwanted water can be disposed in to Cockburn Sound through the existing Woodman Point outfall is 900 litres sec^{-1}, of which 600 litres sec^{-1} can be allocated for the whole catchment area likely to be drained by the Beeliar Channel. If it is assumed half of this discharge rate can be allocated to the subject area, the pump rate would be 300 litres sec^{-1}.

Should the wettest year occur immediately after other wet years it is conceivable that most of the annual runoff would have to be pumped away. With a pumping rate of 300 litres sec^{-1} it could take six months of pumping to get rid of the surplus water, which is proposed to be stored in Lake Yangebup.

For the 15 year period prior to 1988 the water level in Yangebup was normally between 14.6 and 15.8 AHD. This means the lake generally contained between 0.5 and 1.4 million cubic metres of water. If the maximum top water level is to be 16.5 AHD the storage capacity is 2 million cubic metres.

If the maximum level of 16.5m AHD is adopted in the management plan, the storage capacity available at the start of winter is unlikely to exceed 1.5 million cubic metres. Therefore, with drainage outflows likely to regularly exceed 3.5 million cubic metres per annum (i.e. exceed statistical average) long periods of pumping must be expected. Even allowing for continuous pumping throughout winter and well into summer, Yangebup may not provide sufficient storage to cope with wet years and the need for alternative strategies or storage solutions should be evaluated.

In addition to the annual flow issue, there were a number of others, which the TAG felt had not necessarily been resolved. These included the agency to be responsible for the various arterial and sub-soil drainage components. The City of Cockburn has asked the EPA to arrange for the WA of WA to take over all arterial drainage facilities downstream from the first compensating basin.

Although a great deal of concept design work appears to have been done on behalf of the private developers, the TAG was surprised to find that the WA of WA, as the body responsible for arterial drainage schemes, has not developed a model to assist them in evaluating the initial design proposal and different operating strategies. However, it is understood that the WA of WA intends to use the Perth Urban Water Balance model to assist in its management strategy evaluation.

While the TAG was asked as one of its Terms of Reference to suggest alternatives, it did not have the time nor the necessary resources to formulate and evaluate alternative operating strategies for the system.

The lack of a flow chart and long section for the complete system hindered the TAG in making its assessment. Such a "model" highlighting the functions and operating/design criteria for each component was seen as fundamental to the preparation of a suitable drainage management plan.

4.4 COMMENTS ON THE DRAINAGE PROPOSAL

The TAG has examined the documentation outlining the drainage management plan, and the additional information provided by the engineering consultants. It is the opinion of the TAG that the drainage management plan should have been developed in the context of drainage and protection of the Beeliar wetlands from Thomsons Lake to North Lake. However, because the documentation has focussed on the southern section, the TAG has not been able to comment in detail on the northern section.

4.4.1 QUANTITY

Subject to the resolution of any storage problems associated with using Yangebup Lake as the receiving lake for all drainage outflow from the Beeliar Channel, the engineering consultants have produced plans that are engineeringly feasible. More specific on-site information may require some adjustment of the concept; eg after the WA of WA has completed its test-bore in April 1989.

However, there is some doubt about the ability of the system to provide efficient drainage and retain the runoff/subsoil water discharge for a long enough time to strip sufficient quantities of nutrient out of the flow. This could be a particular problem during the "first winter flushing" and all water collected in this event will probably be unsuitable for discharge into either Thomsons or Kogolup Lakes.

4.4.2 QUALITY

The design emphasis so far has been on the basis of Kogolup being available for use as a storage basin. Because Kogolup (north and south) Lake is now recognised as being environmentally significant, the TAG feels that Yangebup may have to then be used as the "storage basin" for larger quantities than previously contemplated. As Yangebup reached its highest level for over twenty years last winter, it is imperative that the management ramifications of using Yangebup Lake as the "storage basin" are checked, particularly whether adequate storage would be available in a series of wet years.

Operationally, the concept would then rely on being able to use Yangebup Lake for storage and handling of the poorer quality discharges. Under these circumstances, the effectiveness of the final stripping basins will be the key to maximising the direct discharges that can be made into Thomsons and Kogolup Lakes.

It is very unlikely that the quality of water in Yangebup Lake will ever be good enough for it to be used to top up other lakes. Therefore, it is important that when the quality is acceptable, water is discharged into Thomsons and Kogolup Lakes whenever possible.

Although the need for monitoring has been accepted by the proponent, to effectively monitor and maintain a surveillance of the buffer lake(s), either weekly or fortnightly testing will be required as the basin of the buffer lake only has 10 days storage at its design flow.

The TAG did not receive any up-to-date document which it believes contained any section sufficiently specific or concise to constitute a drainage management plan proposal for the subject area. G B Hill & Partners did state at one meeting they thought their report produced in 1987 contained a drainage management plan. However, they agreed this report was prepared before the Beeliar Channel was mooted and hence out of date to that degree at least.

From data presented in the developers' reports, the level of phosphorus and nitrogen to be exported from the development is high. The proposal does not adequately address how these nutrients will be handled. It is difficult to quote meaningful figures because they depend so much on the validity of the assumptions. In extremely wet years, phosphorus and nitrogen loadings into Yangebup could be as high as 10 tonnes and 25 tonnes respectively. It could be argued that three quarters of this would be "recovered" and discharged into Cockburn Sound as part of the pumping cycle. This may be so, however with the high loadings there is little doubt that Yangebup would become eutrophic.

The TAG considers that nutrients are a critical issue to be addressed as it does not believe the proposed wetland "buffers" within the proposed development will adequately remove these nutrients on a long term basis.

In addition when water quality is considered in conjunction with quantity the proposal appears to be deficient, perhaps seriously, with respect to storage capacity and duration. The proposed pumping rate to Cockburn Sound will mean a significant detention time will be required under all but dry years. The TAG considers this to be a major point that requires further engineering design and management evaluation because:-

. water will be of high nutrient content giving rise to algal blooms, and associated odours;

. the existing midge problems in the area will be exacerbated; and

. as nutrient rich water is pumped out, botulism can be expected in the lake bodies.

The combination of the above problems will be that a portion of the Beeliar Regional Park will start to detract from the lifestyle and property values of nearby residents rather than enhancing them, while at the same time becoming so unattractive to visitors that it is no longer supported as a valuable regional amenity by the community.

In addressing this problem, the proponent should give attention to removal of nutrients at source (i.e. within urban area) using available technology.

4.4.3 COCKBURN SOUND DISPOSAL LIMITATIONS

The whole drainage concept assumes that any quantity of unwanted water can be transported to the old Woodman Point Wastewater Treatment Plant outfall and disposed of in Owen Anchorage, Cockburn Sound. In 1987 EPA agreed in principle to drainage water being disposed of via the old outfall provided the maximum rate of discharge and the pollution hazard were no greater than those that previously existed when the effluent was being discharged from the sewerage treatment plant.

No information was submitted which demonstrated that this condition could be met. Although there seemed to be no reason to feel it could not be met, the TAG was concerned that an eleventh hour problem could manifest itself. With the aid of a simple model, the TAG listed several scenarios and found that the EPA conditions may not be as easy to meet as generally thought. The main problem being water quality, particularly if Yangebup was being used as the "storage basin and pump sump".

As use of the sewerage outfall was a key facet of the arterial drainage scheme proposed by the WA of WA, the TAG believed the WA of WA, through its statutory responsibility for arterial drainage scheme planning, should be requested to investigate this aspect. The discharge criteria acceptable to EPA could then be set down and incorporated in the required drainage management plan. This is particularly important given the strong commitment by Government to protect and enhance Cockburn Sound.

4.5 ALTERNATIVE DRAINAGE CONCEPTS

As already mentioned, the TAG did not have the resources (or time) to consider alternative concepts (or even the different routes) the suggested to it in the course of its enquiries. However, it felt that there would be merit in examining alternatives for the area to be rezoned or where the development programme could be modified pending resolution of any difficulties.

The TAG even felt it was possible that the rising water-level in Lake Yangebup could become the dominant problem requiring immediate action in preparation for the 1989 winter.

4.6 CONCLUSION

TAG believes the points it has raised need to be considered in the development of an Environmental Protection Policy (EPP) for the Jandakot area, and an overall land use and water resource management strategy.

If it is desirable that some urbanisation proceed prior to the finalisation of the EPP, the TAG recommends that:

- it should proceed on a catchment by catchment basis commencing with the area of high depth-to-water-table based on the Hird Road wetland catchment as illustrated in Figures 8 and 9.

- the best design principles for groundwater protection should be incorporated (see Appendix 3);

- the developer in consultation with the EPA and the SPC install facilities to prevent, treat, remove or otherwise contain nutrients within the urban area;

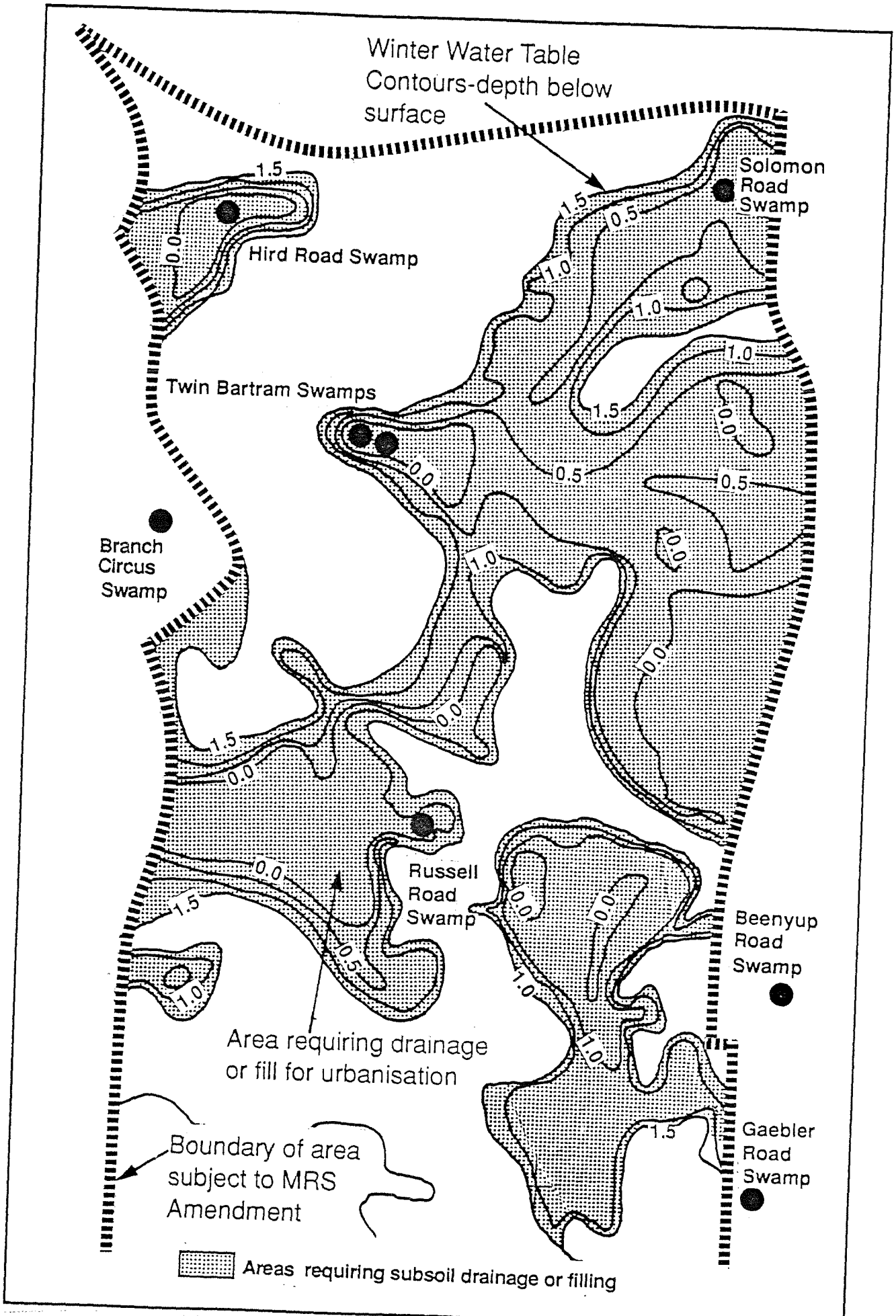


Figure 8. Depth to Water Table Contours

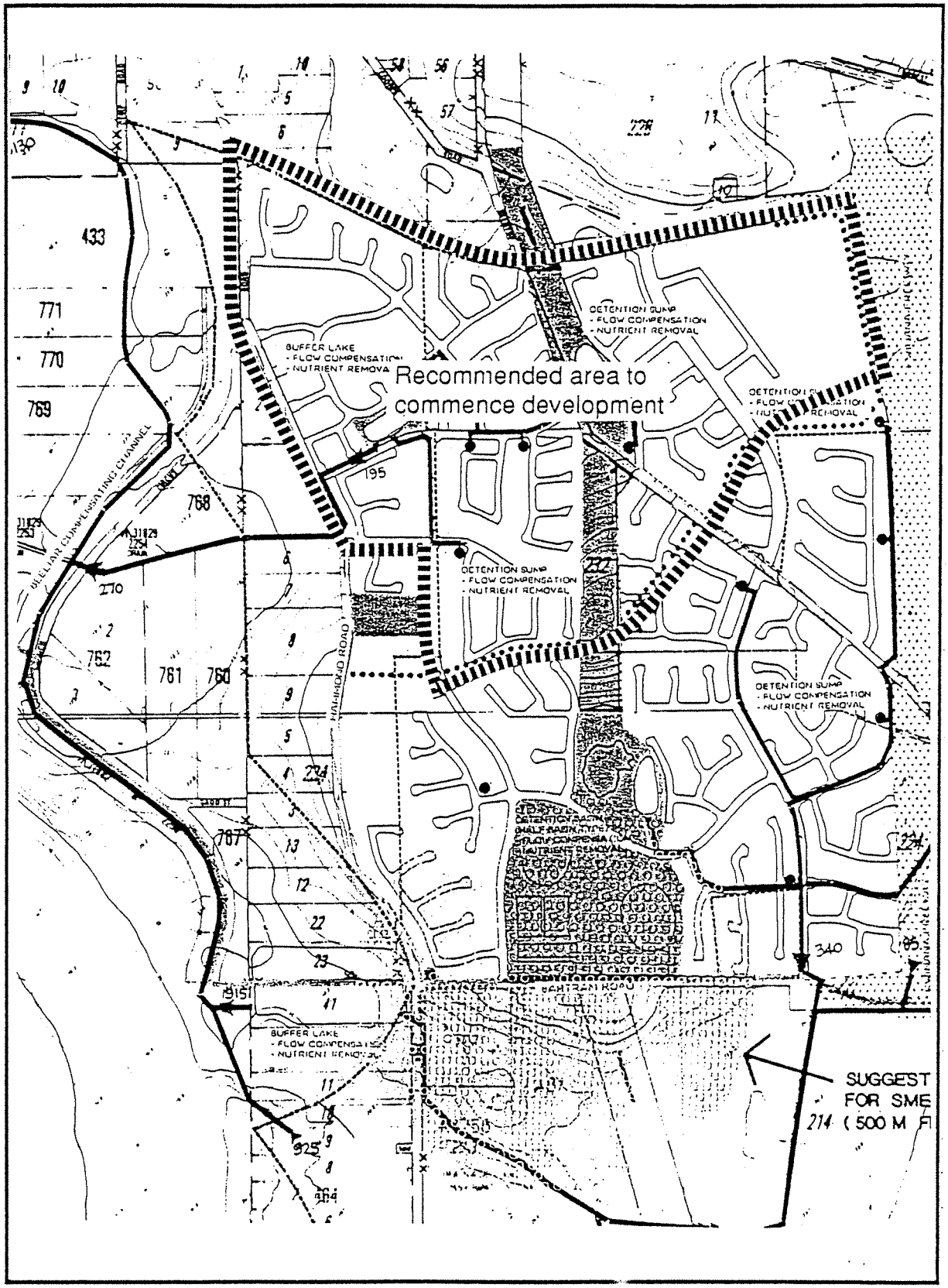


Figure 9. Recommended Area to Commence Urban Development

- the sale of lots should not proceed until a drainage mechanism from the estate Lake is in place and until a pump station has been installed to remove excess water; and

- the development and drainage from it should be monitored and that extension of the urban-rezoning be conditional on successfully demonstrating that criteria with respect to drainage can be achieved on an ongoing basis.

5. CRITERIA FOR FUTURE PROPOSALS AND ALTERNATIVES

In this Section we wish to discuss how the SPC as a proponent, can satisfy the EPA according to the need for protection as given in Chapter 3 and the drainage requirements as given in Section 4. The approach that we have taken is firstly to describe the criteria for protection of the Beeliar wetlands. Then we describe the management needs of those wetlands. Finally, we describe the criteria for urban drainage of the South Jandakot Area.

5.1 CRITERIA FOR THE PROTECTION OF THE BEELIAR WETLANDS

If the Beeliar wetlands are to retain any semblance of their natural state then there is a need to protect them from the effects of urbanisation. Otherwise the problems currently so obvious in Lake Yangebup will spread to other lakes in the system. So the criteria proposed are:

(a) drainage systems from urban areas surrounding the Beeliar wetlands should be so arranged that excess water can be diverted around the wetlands rather than through them. This allows the excess water to carry away excess nutrients;

(b) pump or drainage systems are required in each wetland so that, should levels become too high, excess water can be removed. Wetlands, especially Thomsons Lake and Kogolup Lake should be managed to dry out frequently in late summer (consistent with CALM criteria);

(c) the drainage system should be such that, should the lakes receive too little water, flows low in nutrients can be diverted into the lakes;

(d) any diversion channels should not be within, but may form a suitable boundary to the Beeliar Regional Park;

(e) nutrient stripping devices should be required wherever it may be necessary to reduce the nutrient content of water entering wetlands.

(f) the performance of nutrient stripping devices is at present unknown. Therefore the devices first installed for this purpose:

  - should be the best available design;
  - should be accompanied by a research programme to monitor their effectiveness;
  - should be put in with an accompanying bond, so that any system failure can be rectified; and
  - should remove not only nitrogen and phosphorus, but also heavy metals, hydrocarbons and insecticides.

(g) devices to strip nutrients should not be within Beeliar Regional Park unless they bring other benefits to the Park. The monitoring of nutrient stripping devices is necessary until such time as their performance can be guaranteed;

(h) wherever possible, drainage waters should enter buffer lakes outside the Beeliar Regional Park, so that flows to major wetlands are not unregulated storm flows;

(i) these buffer lakes should themselves have vegetation buffers around them, so that any midge problems do not cause nuisances to local residents; and

(j) any drainage system should provide for the disposal of waters which are in excess of the needs of the Beeliar wetlands. The disposal system should be designed so that the excess water is used beneficially if possible and does not pollute other water bodies (eg Cockburn Sound).

(k) wetlands which are high priority conservation areas or whose primary function is conservation should not be used as buffer lakes, compensating, or storage basins in any proposed drainage.

5.2 MANAGEMENT OF THE BEELIAR WETLANDS

As detailed in Section 3, the Beeliar wetlands have a number of problems requiring immediate treatment. The TAG proposes the following solutions:

. North Lake

Excess water needs to be drained away and, since the water quality in North Lake is now better than that in Bibra, draining the water into Bibra Lake would be beneficial to both.

There are two major drains leading into North Lake, the Murdoch drain which has been a major source of nutrients and Kardinya drain. Options for managing the Murdoch drain are currently being investigated. The need for local treatment such as nutrient stripping and buffer lakes, associated with the Kardinya drain should be determined.

. Bibra Lake

High water and pollution levels have been a feature of Bibra Lake in recent years, with the sanitary landfill site on the southern margin considered to contribute to the pollution. Removal of the latter source of pollutants is considered impossible, so flushing out nutrients by drainage of better quality water into Bibra Lake and poorer quality water from Bibra Lake is seen as an appropriate response. Nutrient stripping in major drains into the lake will alleviate some of the pollution problems.

. Little Rush Lake and South Lake

These lakes do not require active water management at this stage, but water quality and quantity should be monitored and installation of nutrient stripping and sedimentation basins into the existing drains should be planned.

. Yangebup Lake

At this time, Yangebup Lake is suffering from too much polluted water and urgently requires remedial treatment. It smells badly and is a source of large swarms of midges which plague local residents. Removal of polluted water from the lake requires a pumping station and a place to put the water.

The settling ponds of the wool scouring facility have been considered to be the major, but not the only source of pollutants flowing into Lake Yangebup. The drain from the South Lakes Estate is thought to be a major source of excess water creating the currently very high levels which are damaging the fringing vegetation.

Providing a pump-out station is installed, Lake Yangebup can receive water from other lakes, since all water entering will be of better quality than current lake water. It may be beneficial to pump Lake Yangebup dry one autumn, so that polluted sediments can be removed from the lake and islands can be created for waterfowl. In the long term, the water levels and quality in the Lake should be carefully regulated to assist in the control of midges and the rehabilitation of the buffer zone.

. Kogolup Lake

The hydrographs of Kogolup Lake and Thomsons Lake indicate that the water level of Kogolup Lake has risen approximately 0.7 metres in the last 10 years (1978-1987) despite low rainfall (Figure 5). This could be due to the effects of very high water levels in Yangebup Lake or other effects of urbanisation. Pumping out facilities should be provided, as well as the ability to allow water of suitable quality to enter Kogolup Lake.

Kogolup Lake is biologically diverse and the present water quality is comparable to that in Thomsons Lake. An increase in water levels could adversely affect the fringing vegetation. Increased nutrients could produce algal blooms, midge problems and botulism. These are not a problem at present.

As it is intended that Kogolup Lake should become a conservation area and wildlife refuge within the Beeliar Regional Park, the TAG recommends that it should not be used as a storage basin for drainage waters.

. Thomsons Lake

The spread of macrophytes is an indication that nutrient loadings to Thomsons Lake are becoming critical. Control of the quality of water entering the lake is therefore an urgent priority. Polluting industries, such as piggeries and stables may need to be removed from the area, or redesigned to contain pollutants, and the quality of water entering the Lake needs to be controlled by diversion and by nutrient stripping.

The Ministerial requirements require the SPC to produce a package of mechanisms (including monitoring) to control water levels in the Thomsons Lake open space area and other wetlands within the proposed Beeliar Regional Park. We have attempted to outline above, the mechanisms that we see would be required. Associated with these proposals would need to be a specification of management structure for the wetlands and for water and nutrient management, a timetable and a list of commitments by the SPC and others to the installation of the management equipment, a managing authority and a management plan. An associated monitoring programme needs to be specified at the same time.

5.3 CRITERIA FOR URBAN DRAINAGE FROM THE SOUTH JANDAKOT AREA

A drainage management plan for the South Jandakot area is also required and in this section we outline the requirements for such a plan.

(a) The area subject to rezoning overlies the Jandakot groundwater mound. The Jandakot Stage II borefield is currently subject to environmental review. What is needed in this rezoning application is a clearly stated package of mechanisms, acceptable to the WA of WA, which will protect the Jandakot mound from pollution. It should include an analysis of the likely sources and location of pollution including:

- run off from roads;
- nutrient use in gardens;
- control in special use areas (shopping centres, industrial areas, petrol stations etc);
- control of hazardous loads; and
- construction of drainage facilities from roads (including the possibility of closed systems to contain spillages).

(b) The area subject to rezoning also contains important wetlands. A unpublished study by Le Provost, Semenuik and Chalmers identified Hird Road Swamp, Twin Bartram Swamps, Branch Circus Swamp, and Solomon Road Swamp. To the east, and within the drainage catchment area lie Bartram Road Swamp, Beenyup Road Wetland and Gaebler Road Swamp. In the information provided by the consultants to the proponent, some detail was given of the proposed treatment of Solomon Road Swamp. This proposed treatment needs to be discussed with officers of the Evaluation Division of the EPA and details need to be provided of the treatment for the other important wetlands.

(c) The area in the catchment of the Bartram Road Drain and especially the area east of the proposed freeway extension will require extensive subsoil drainage to achieve design standards required for urbanisation. This will create problems in the maintenance of the important Jandakot wetlands listed above and also significantly increase the concentration and amount of run-off flowing towards Thomsons Lake. This drainage requirement is predicted on a land use of 90 per cent urban 10 per cent public open space. The TAG believes that alternatives of 80 per cent and 70 per cent urban should be presented to the EPA for consideration.

(d) The proposals should also contain details of drainage flows in the channel system in normal, one in five, one in ten and one in one hundred year flood events. These should include dimensions of compensating basins, operating mechanisms of buffer stripping devices, overload safety devices, flows on roads in one in one hundred year flood events etc.

(e) The control of health, safety and nuisance hazards associated with the proposed drainage system should also be covered.

(f) The stages of urbanisation mentioned in Ministerial condition number three should be by natural catchments starting with the Hird Road Catchment and appropriate monitoring and management should be proposed and implemented at the same time. The monitoring and management programme proposed should be integrated into a monitoring and management programme for the Beeliar wetlands from North Lake to Banganup Lake.

6. CONCLUSIONS AND RECOMMENDATIONS

As urban development surrounds them, the wetlands of Perth suffer from a distinct sequence of degradation. The first stage is an increase in the flow of water to them. The increase is due to a decrease in transpiration as the vegetation in the catchment is removed, together with increased run-off due to the replacement of soil surfaces with impervious bitumen and tiles. The quantity of flow as well as the magnitude of storm flows increase, as the effect of urban drainage is to transfer the water more rapidly to the wetland. This has happened to North Lake, Bibra Lake and Yangebup Lake. It appears that Lake Kogolup and Thomsons Lake are beginning to experience the same process.

The second stage is pollution in the form of increases in the quantity of chemicals flowing into the wetland due to the use of fertilizers, or from industrial processes. It is these which cause eutrophication and midge problems. Eutrophication and midge problems are already being experienced at North Lake, Bibra Lake and Yangebup Lake.

The third stage is the loss of species diversity due to frequent algal blooms, outbreaks of botulism and the death of fringing and emergent vegetation due to inundation. Such effects are evident in some urban wetlands such as Lake Monger and Lake Yangebup.

A fourth stage is a drying up of the lakes as trees in parks and gardens evaporate more water and bores are sunk to supply landscape needs. Examples are Perry Lakes and Blue Gum Lake, which have to be artificially maintained.

6.1 ENVIRONMENTAL MANAGEMENT OF THE BEELIAR WETLANDS

In order to assist with the process of defining what level of control is required in the drainage management plan which should satisfy the Minister for Environment, the TAG has collated information on the major wetlands of the Beeliar Regional Park. This information is provided in Section Three.

The evidence is that the Beelair wetlands are already suffering from stage one and stage two effects and that the lakes north from and including Lake Yangebup are in urgent need of active management. The levels of water and pollution currently being experienced in these lakes are damaging these wetlands. Given a year with rainfall ten percent or more above average, severe flooding is very likely to occur.

RECOMMENDATION ONE

The TAG recommends that the Environmental Protection Authority request the Water Authority of WA undertake active management of water quantity and quality in the North Lake to Yangebup Lake area, both for the protection of these wetlands and to avoid flooding.

Options include the establishment of groundwater borefields for domestic supply under existing and proposed urban subdivisions, pumping the excess water out through the Woodman Point sewerage outfall, or using it elsewhere.

The Minister for Environment may consider the need to halt urbanisation within the catchment of the Beeliar wetlands if nothing is done to remove the excess water that is accumulating in them.

Chapter three also contains classifications of the Beeliar wetlands from criteria in EPA Bulletin 374 and from the draft report of the Beeliar Regional Park Consultative Committee. These classifications are used to derive management criteria for the major wetlands of the proposed Beeliar Regional Park.

RECOMMENDATION TWO

The TAG recommends that the Environmental Protection Authority request the Beelair Regional Park Consultative Committee to advise on criteria for the protection of the wetlands of the Beelair Regional Park as a matter of priority. Until alternatives are available the TAG recommends that the criteria presented in this report are used.

Probably the most significant component of the classification is the high conservation status accorded to Kogolup Lake, both North and South Sections. There are also many references in previous reports on the Beeliar Regional Park where the high conservation value of Kogolup Lake is mentioned.

RECOMMENDATION THREE

In view of the high conservation value of Kogolup Lake, the TAG recommends that it should not be used as a storage basin.

The TAG believes that the efforts to maintain and improve the conservation values of Kogolup Lake should be increased. The acceleration of land purchases, the removal of grazing and horse-riding and the active replanting of the area are all needed if conservation objectives are to be achieved.

On the other hand the TAG believes that the use of Yangebup Lake as a storage basin could provide benefits in assisting with the clean-up of that Lake. Given the large numbers of problems (water level, nutrient and heavy metal levels, algal blooms and midge problems), there is a need to take a positive approach to the management of this wetland.

RECOMMENDATION FOUR

The TAG advises the Environmental Protection Authority to request a specific study on Lake Yangebup, preferably in conjunction with the Department of Conservation and Land Management and the Cockburn City Council. The study should develop a plan of action to overcome the water quality and quantity problems currently present in this Lake.

In 1987 students of environmental management from Murdoch University completed a management proposal document for Yangebup Lake. This had been initiated by several Government Departments.

The document is currently being used as a guideline for management by the SPC with it being implemented as far as is possible. Following the establishment of the Beeliar Regional Park the proposal would be incorporated in a formal management plan which would be subject to public review.

The study suggested in Recommendation 4 should address the specific environmental problems which exist in Yangebup Lake, in particular the water quality and quantity issues.

6.2 URBANISATION AND WATER MANAGEMENT

The WA OF WA with EPA (or with support from EPA and CALM) has been stressing the need for an overall land-use and water resources management plan covering the central recharge area of Jandakot Groundwater Mound. The WA of WA believes that its new Land Planning and Groundwater Resource Protection Policy now provides for the integration of urban development with the management of a public water supply source, as long as the importance of the Primary Source Area is recognised.

However, it is imperative that this integration is carried out in accordance with a pre-determined stragegy and overall plan. Such a plan must include a realistic monitoring program which will indicate possible difficulties before viable options are closed.

The TAG would expect such a plan to embrace the WA of WA's statutory responsibility for the arterial drainage schemes, the operation of main drains, and the groundwater abstraction guidelines for the public and private water supplies.

RECOMMENDATION FIVE

The TAG advises the Environmental Protection Authority that before the rezoning and drainage plans are finalised there should be a land use and water resource management strategy (integrated catchment management plan) developed for the Jandakot groundwater mound by the State Planning Commission, Department of Conservation and Land Management & Water Authority of Western Australia with advice from the Environmental Protection Authority. This strategy need not go into detail initially, but should aim at identifying areas immediately suitable for residential development, conservation and groundwater protection.

From the unpublished study of Le Provost, Semeniuk and Chalmer mentioned above a number of important wetlands within the rezoning area have been identified. So far there has been no official study to delineate which parts of the higher ground should be set aside for conservation, parks and recreation. A Jandakot Botanical Metropolitan Park was proposed in SPC Working Paper No 17 (1987). The objectives of the proposed park are to maintain a sense of local identity, to protect rare flora and fauna and to provide a bush corridor through the urban area in place of the rural wedge of Stephenson Plan.

While it accepts that the arterial drainage components must be designed to handle extreme rainfall events without dependence on the WA of WA groundwater abstraction strategy, the TAG believes that the strategy adopted for pumping out groundwater should be structured to maximise the quantity of water discharged from the drainage system. This in turn would increase the quantity of grourdwater that could be harvested (pumped out) each year and at the same time help control adverse movement of the water-table.

RECOMMENDATION SIX

The TAG recommends that the Environmental Protection Authority request the Water Authority of Western Australia to exercise its statutory responsibilities for water resource management and arterial drainage, to take over the development of the drainage management plan for both the South Jandakot area and the Beeliar wetlands. Furthermore, the costs of preparing the plan, carrying out monitoring and assessment, catering for any special environmental provisions and the implementation of the plan, should be incorporated in a special headworks contribution levy payable before any subdivision development is approved.

Quite obviously the WA of WA will need to liaise with the SPC and local government concerning urban layout and rezoning and with CALM and the EPA concerning protection of important conservation areas. No doubt urban developers will need to design local drainage schemes, but these should be in proposed urban subdivision cells, not on a regional basis.

Although the TAG did not specifically meet with any MRD representatives, it did feel that the extension of the Kwinana Freeway was an important development proposal within the area being considered for rezoning. The compatibility of the Freeway drainage criteria used by MRD should be evaluated with those adopted for the arterial drains, particularly with respect to the measures for containing accidental spillages of hazardous materials and liquids.

RECOMMENDATION SEVEN

The TAG recommends that the Environmental Protection Authority request the Main Roads Department to provide design details of the drainage systems to control runoff from the Kwinana Freeway extension over the Jandakot groundwater mound. It is important that the design of the Freeway drains is compatible with the arterial drainage system and management strategy, particularly for the containment of any accidental spillages or situations hazardous to groundwater.

6.3 THE DRAINAGE PROPOSAL

The fundamental issue facing the TAG is, has the State Planning Commission (as proponent for the rezoning under the Metropolitan Regional Scheme), fulfilled the conditions specified by the Minister for the Environment; namely:

"1. Prior to the initiation of rezoning and reservation proposals, the proponent shall outline, to the satisfaction of the Minister for the Environment, a proposal for a drainage management plan for the South Jandakot area, which shall establish a package of mechanisms (including monitoring) to control water levels;

(1) In the proposed urban areas, which is acceptable to the Water Authority of Western Australia.

(2) In the Thomsons Lake open space area and other wetlands within the proposed Beeliar Regional Park, which is acceptable to the Environmental Protection Authority, Department of Conservation and Land Management and the Water Authority of Western Australia.

This outline of the proposal shall be made available to the public by the proponent, prior to the rezoning being advertised.

2. Finalisation of the proposed rezoning and reservation shall not occur, until the drainage management plan referred to in condition 1 has been prepared to the satisfaction of the Environmental Protection Authority, Water Authority of Western Australia and the Department of Conservation and Land Management."

Although drainage plans have been submitted, the major limitation of the proposals so far has been a lack of drainage management plans.

Both the WA of WA and CALM have indicated in their submissions to the EPA on the drainage management proposal, that they are not satisfied with the proposal. Our collective opinion is that the EPA should not be satisfied either.

RECOMMENDATION EIGHT

The TAG advises the Environmental Protection Authority that it believes that the Ministerial conditions applying to the proposed Metropolitan Region Scheme Amendment for rezoning the South Jandakot area have not yet been met.

Consequently the TAG believes that the Minister for Planning should be advised that finalisiation of the proposed rezoning should not proceed at this time.

The TAG also believes that the proposed Beeliar Compensating Channel has some merit, but the design needs to be better adapted to suit the drainage requirements of the Beeliar wetlands and the local landscape.

RECOMMENDATION NINE

The TAG recommends that the Beeliar Compensating Channel as proposed should not be approved, but that alternative piped and open drainage systems need to be investigated to regulate water quantity and quality in the Beeliar wetlands.

6.4 COMPONENTS OF AN ACCEPTABLE PROPOSAL

In Section 5 the TAG has tried to assist by proposing what it sees as an adequate response to the Ministerial conditions quoted above.

The TAG proposes that the following conditions need to be met:

1. The drainage criteria for the Beeliar wetlands in Section 5.1 (a) to (k) be met.

2. The management problems of the Beeliar wetlands outlined in Section 5.2 be addressed.

3. A drainage system which specifies water flows from the area for average and one in five, one in ten and one in one hundred year wet years, with estimates of flows in peak flow conditions (eg heavy frontal rain occurring over a three day period on a previously saturated landscape);

4. The criteria for urban drainage from the Jandakot area described in Section 5.3 (a) to (f) be met.

5. A nutrient stripping scheme wholly contained within the development area should be specified which reduces nutrient flows from both groundwater and infrequent flood overflows to acceptable levels (see Table 5). The local problems of smells, midges and mosquitoes from these nutrient stripping devices, if they occur, will need to be addressed.

6. A Management Plan be supplied for the drainage scheme which should contain operating conditions for the average one in five and one in one hundred wet years for water disposal, together with contingency plans to cover perceived problems. It should include:

   - a monitoring program to include surface and groundwater flows;
   - details of the criteria which would constitute failure of the scheme and the need for remedial action;
   - conjunctive extraction of water by the WA of WA and cessation of that process should urbanisation pollute the groundwater;

- possible actions to rectify water level changes in Thomsons and Kogolup Lakes which are to the detriment of the ecosystem;
- commitments by the SPC, that in the event of further proposals for rezoning within the catchment of the Beeliar wetlands, a redesigned drainage system will be required, as this proposal does not address additional areas.

In addition the TAG draws the attention of the EPA to the comments by Mr David Hedgecock, Convenor of the Urban Design for Water Conservation Research Group. Mr Hedgecock was provided with the designs supplied by the developers by the TAG and asked to comment upon them. His comments are contained in Appendix 3.

6.5 ACTIONS PROPOSED TO AVOID FUTURE PROBLEMS

Some of the action required to avoid future problems in the development of the area are contained in the recommendations above. But the TAG also wishes to echo the caution expressed in Ministerial Conditions 3 and 4.

"3. Once the drainage management plan has been prepared and approved, it shall be progressively and adaptively implemented in parallel with each subdivision stage, including monitoring of the effects of each stage of the drainage management plan. This condition is intended to only require that part of the drainage management plan to be implemented which relates to the portion of land to be subdivided and not for the whole drainage plan to be constructed at once.

Where the Environmental Protection Authority believes that monitoring shows undesirable environmental impacts are occurring, further stages of the proposal shall not proceed, until changes to the drainage management plan, or development proposal are made to the satisfaction of the Environmental Protection Authority."

"4 Prior to subdivisional approval being granted, reporting mechanisms (to the satisfaction of the Environmental Protection Authority, Department of Conservation and Land Management and the Water Authority of Western Australia) for monitoring of the drainage management plan shall be established. These should provide for reporting on the progress of the development, the functioning of the drainage plan and the impact on the wetland ecosystems. The reporting shall be as follows:

. annual reports;

. detailed review of progress after three years, with decisions to be taken at that time on whether or not and under what conditions further subdivision can proceed.

These reports shall be submitted by the proponent (or any other agency which has accepted this responsibility) for review to:

. Department of Conservation and Land Management;

. Water Authority of Western Australia;

. Environmental Protection Authority, and

with the advice from these agencies forming the basis for adjustment or continuation of the drainage management plan."

RECOMMENDATION 10

The TAG recommends to the EPA that should urban development proceed prior to the finalisation of an Environmental Protection Policy, then:

- it should proceed on a catchment by catchment basis commencing with the area of high depth-to-water-table based on the Hird Road wetland catchment as illustrated in Figures 8 and 9;

- the best design principles for groundwater protection should be incorporated (see Appendix 3);

- the developer, in consultation with the Environmental Protection Authority and the State Planning Commission, should install facilities to prevent, treat, remove or otherwise contain nutrients within the urban area;

- the sale of lots should not proceed until a drainage mechanism from the estate is in place, and until a pump station has been installed to remove excess water; and

- the development and drainage from it should be monitored and extension of the urban rezoning should be conditional on successfully demonstrating that criteria with respect to drainage can be achieved on an ongoing basis.

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RESPONSES BY G B HILL & PARTNERS

TO QUESTIONS PUT BY THE TAG

1. Q. Can you provide a brief description of the drainage system, its components and how they will function?

A. The principles upon which the design of drainage for the area is to be based are outlined in the South Jandakot Water Resources Management Plan, (SJWRMP) these being:

1.1 Conservation of the Water Resource in the Area.

The SJWRMP confirms that in an average year, from an available 90 million cubic metres per year from rainfall in the Public Water Supply Area, urbanisation could make available an additional 12 million cubic metres of water currently lost to evapotranspiration.

1.2 Utilisation as far as possible of the existing City of Cockburn drains which currently discharge by gravity towards Thomsons Lake which is the lowest level lake in the wetland chain.

Piping and re-routing of the existing drainage will occur where necessary to conform with road and structure planning.

1.3 Installed drainage including subsoil drains to be at levels to limit groundwater levels to the summer water profile as outlined in the SJWRMP and achieve the post development contours, outlined in the Study Report.

1.4 Principles of drainage recharge to be included in the drainage system with the installation of recharge basins and reverse flow subsoil drainage.

1.5 Trunk drainage flows to pass through compensating recharge basins to attenuate peak flows and retard flows to settle sediment.

1.6 As outlined in the SJWRMP, all drainage flow to be held in buffer basins prior to discharge into the Beeliar system, in order to reduce nutrient concentration below those presently occurring.

1.7 Control of water levels in Thomsons Lake to ensure the Department of Conservation and Land Management's preferred regime of a dry lake bed in autumn.

1.8 The drainage proposed within the development area is outlined in two reports prepared by Sinclair Knight and Partners and by G B Hill and Partners Pty Ltd. These reports have been forwarded to the City of Cockburn and to the Water Authority of WA.

The compensating basin design basis will be the 10 year storm event. The urban drainage design basis will be the 5 year storm. For storm events up to the 1 in 100 year flood occurrence road geometry will be provided to enable the excess stormwater to be contained within road reserves and detention basins without flooding residential lots.

Design is according to the Institution of Engineers Australia "Australian Rainfall and Runoff 1987" and Australian Road Research Board publication "Storm Drainage Design in Small Urban Catchments".

Forwarded with this summary is a plan indicating the drainage layouts and compensating basins included in the Sinclair Knight and G B Hill reports together with the 10 yr and 100 yr storm event flows.

The development area is in the order of 12 metres higher than Thomsons Lake and all the above flows will pass by gravity flow to the Beeliar system without the risk of flooding the development area.

1.9 The outlet drainage and recharge system incorporates the Beeliar Channel to provide the facility to bypass water around Thomsons and Kogolup Lakes to either the south or north of the lake.

To provide the complete facility to enable full flexibility for the proper management of water levels in Thomsons Lake it will be necessary to install a low capacity pump in the lake to remove water if required.

The outlet pumping station location adjacent to Yangebup Lake is proposed utilising either or both of Yangebup and North Kogolup Lakes as a buffer storage. It is proposed that the pump station will have a capability of pumping from both North Kogolup and Yangebup Lakes.

The alternative location would be an outlet and recharge pumping station at Thomsons Lake utilising this lake as a buffer storage. This alternative is not acceptable to CALM.

2. Q. The drainage management plan will have to contain strategies that recognise both long-term events and short-term ones, eg several years of above average rainfall or an intense rain storm of only 12 hours duration. Please describe how the system will work quoting design figures for a 1 in 10 yr rain storm event and a 1 in 100 yr rain storm event.

A. Standard design practice is to provide for long-term and short-term storm events.

Relatively small quantities of water result from statistically high intensity rainfall although these short-term storms can cause local instantaneous flooding if appropriate drainage design is not implemented.

As previously outlined the 10 yr and 100 yr storm flow rates are shown for various parts of the drainage system on the attached plan. It must be again emphasised that the quantities of water for these events are relatively small.

The capacity of the Beeliar Channel is 5,000 litres per second. The estimated 10 yr storm flow is 3,100 litres per second, hence no overflow into Thomsons Lake will occur in this situation unless required to occur as a lake management policy.

The long-term estimated cumulative outflows from the catchment area for dry average and wet years are summarised in the following table:

TOTAL DRAINAGE FLOWS

Wettest Year

0.31 0.26 0.28 0.23 0.48 0.97 0.62 0.84 0.55 0.43 0.42 0.40
5.78 ($Mm3/yr^{-1}$)

Average Year

0.20 0.12 0.12 0.13 0.30 0.46 0.49 0.47 0.36 0.32 0.25 0.23
3.45 ($Mm3/yr^{-1}$)

Driest Year

0.08 0.08 0.03 0.02 0.14 0.32 0.32 0.27 0.19 0.21 0.18 0.15
1.98 ($Mm3/yr^{-1}$)

It is again emphasised that the urban drainage system will operate by gravity flow into the Beeliar Channel and outlet recharge system, the operational details for which are outlined below.

3. Q. Further to the last question please describe how the system design caters for a long period of wet years quoting quantities that would have to be coped with within the area and those that may have to be exported?

A. The cumulative long-term drainage flows for various types of winters are outlined in the previous paragraph.

The worst case scenario in regards to capacity is concerned with the wet winter year when it may not be considered advisable due to potential flooding problems not to recharge or transport water between lakes in which case 5.78 million cubic metres of water would need to be exported. This volume could be pumped during the winter months at the Water Authority allocated capacity from the development of 300 litres per second.

4. Q. Describe any function or operation differences envisaged in the drainage management strategy that may be necessary to cope with:

(a) a dry period eg. a 3 yr run of 15% below average rain drought;

(b) average rainfall periods eg 3 consecutive years of average rainfall;

(c) a wet period eg a 3 yr run of 20% above average rainfall?

A. (a) A dry period of 3 years with 15% below average rain.

With 15% below average rainfall the drainage flow available for recharge would reduce to an estimated 2.9 million cubic metres per year.

During this dry period the potential for recharge within the development area through reverse flow in the subsoil drainage system and other installations would be maximised.

The need to transfer water between lakes to retain existing regimes may be necessary during this occurrence.

Other than peak storm periods flow in the drainage system would be minimal.

(b) The 1988 winter was slightly above average.

The increase in Water Authority extraction resulting from the second stage borefield together with continued development would be monitored to define acceptable strategies for recharge.

(c) A three year period of 20% above average rainfall will result in an estimated outflow of 4.3 million cubic metres per year. Increased pumping would be required.

5. Q. A key aspect in the drainage approach is the use of sub-soil drains in lieu of filling low areas. (It has been noted that some areas will actually need to be filled and sub-soil drained). Can you give the comparative costs of filling low areas to avoid the need for sub-soil drains?

A. The previously mentioned drainage reports prepared by Sinclair Knight and Partners and G B Hill and Partners Pty Ltd outline the areas in which filling and subsoil drainage is intended.

Subsoil drainage is required in lower area when filled in order to control groundwater levels. It is not possible to completely avoid sub soil drainage due to higher ground water profiles that may occur in high rainfall winters.

The existing City of Cockburn open channel drainage system has an effect similar to subsoil drainage resulting in groundwater stabilising at the summer levels with the added disadvantage of increased evaporative losses. The time taken for groundwater level stabilisation for an open drainage system takes longer to occur.

Subsoil drainage systems prevent high groundwater levels occurring and hence also reduce evaporative losses.

Where piped drainage systems are installed it is necessary to install associated subsoil drainage to affect adequate drainage control in the higher level groundwater areas.

To fill areas without subsoil drainage to a level to ensure that groundwater levels do not reach the surface in wet periods requires considerably more sand fill to the extent that this concept becomes economically impractical.

6. Q. How has the question of the "what may be the community's preferred beneficial use" for the wetlands been addressed and what was the result of any evaluation?

A. This has been addressed in a survey carried out in 1988 by CSIRO the results of which were presented in a paper by Mr G Syme to the Swan Groundwater Management Conference held in October 1988.

Within the development area a survey was carried out on eight seasonal wet areas. Of these three are not affected. Of the remaining five the Russell Road Swamp is intersected by the Kwinana Freeway and Branch Swamp by the existing Westfield Main Sewer. The groundwater profile for the remaining areas will result in the areas not remaining in their present form. Of the 198 hectares of seasonal wet areas 169 hectares are not affected.

7. Q. Who do you understand will be (or believe should be) responsible for the operation, maintenance and replacement of:

(a) sub-soil drains;

(b) piped drains in urban area;

(c) compensating basins with or without nutrient stripping ponds;

(d) buffer lakes;

(e) compensating channel?

A. (a) Subsoil drains - City of Cockburn which is the usual practice.

(b) Piped drains in urban area - City of Cockburn.

(c) Compensating basins with or without nutrient stripping ponds - City of Cockburn.

(d) Buffer Lakes west of Hammond Road - Water Authority.

(e) Compensating Channel - Water Authority.

8. Q. What is the expected life of the sub-soil drainage pipes and system in general? What other areas of Perth rely on a sub-soil drainage system? Have any of these experienced any problems?

A. All subsoil drainage installed within private land is covered by easements in favour of the local authority to allow maintenance. The drains are installed in straight line alignments with manholes within each property and at direction changes.

Subsoil drainage is accepted worldwide as a form of maintaining groundwater profiles in flat sedimentary sand plain topography. A form of subsoil drainage is utilised to control seepage within water reservoir dam embankments and also for retaining walls.

Nearly all Cannington is subsoiled successfully.

The area of Wilson was subsoiled in the vicinity of 35 years ago and it is understood that this is still satisfactory.

Other areas which have subsoil drainage include Waterford, Karawarra, parts of Gosnells, Armadale, Willetton, etc.

9. Q. Does the design of the proposed drainage system allow for further urban development to take place outside the current rezoning proposal.

A. The proposed drainage system serves the total catchment the eastern section of which remains rural. No allowance is included for the rural areas in the context of this becoming urban in the future.

10. Q. What other routes were considered when determining the "escape cum export" route for the drain, eg was the Peel Drain considered as a possible discharge route?

A. The existing "natural" City of Cockburn drainage routes allowing for gravity flow for the catchment were the basis for design.

The Peel Drain was considered, however the advice received from the Water Authority at the outset was that the extension of the drainage system connecting to this drain would not be approved. This drain is away from the natural catchment flow, however connection of the southern section of the development could be considered in the future.

11. Q. Could one of the inland wetlands be used as a holding/storage basin in lieu of transporting large quantities to the Beeliar lake chain?

A. It is not feasible to "hold" water at inland wetlands due to the existing and proposed drainage systems.

Recharge within the inland areas is feasible if the groundwater level is lower than that of the drains. This would occur at the end of dry periods.

12. Q. What provisions have been made for drainage from the Freeway when extended, particularly for major spill situations from road accident?

A. Runoff flows for the Freeway have been allowed for in the drainage design.

As to whether the transport of bulk chemicals along the Freeway will be approved is yet to be determined. The transport of chemicals is controlled by the Department of Transport along designated routes.

If chemicals are to be transported then it is proposed that imperviously lined intercept basins will be required for the Freeway drainage within the Freeway for the collection and holding of chemical spillage and any associated washdown.

13. Q. What timing do you feel is necessary for construction of the channel?

A. The construction of the channel is dependent upon the rate of development. Construction commencement is envisaged in approximately 18 months to 2 years.

APPENDIX 2

SIMPLIFIED WATER BALANCE OF THE PROPOSED URBAN AREA

By K Taylor, Water Authority of WA

An estimate of the current water balance in the area proposed for urbanisation (Figure 3.1 South Jandakot Development Water Resources Management Plan, January 1987) is illustrated overleaf. Also shown is the predicted water balance following urbanisation and establishment of the subsoil drainage system as proposed.

Water input to the area is about 14 x 10^6 m^3 yr^{-1}, principally from rainfall. The major output is by evapotranspiration losses. Drainage from the area to wetlands to the west is a lesser component of the water balance. Total input to the wetlands is estimated to be about 5 x 10^6 m^3 yr^{-1}, principally from groundwater flow.

In the modified water balance following urbanisation, drainage flow is predicted to be about 4 x 10^6 m^3 pa, under average conditions. Groundwater outflow is predicted to increase marginally because of increased recharge in urban areas on the higher land. Total input to the wetland area to the west of the urban zone is predicted to increase to about 9 x 10^6 m^3 yr^{-1}.

The possible effects of planned increased public water supply abstraction by the Jandakot Groundwater Scheme are not included in the predicted modified water balance for the area. Increased abstraction by the scheme could reduce the excess drainage flow and groundwater flow to the wetland area under average conditions.

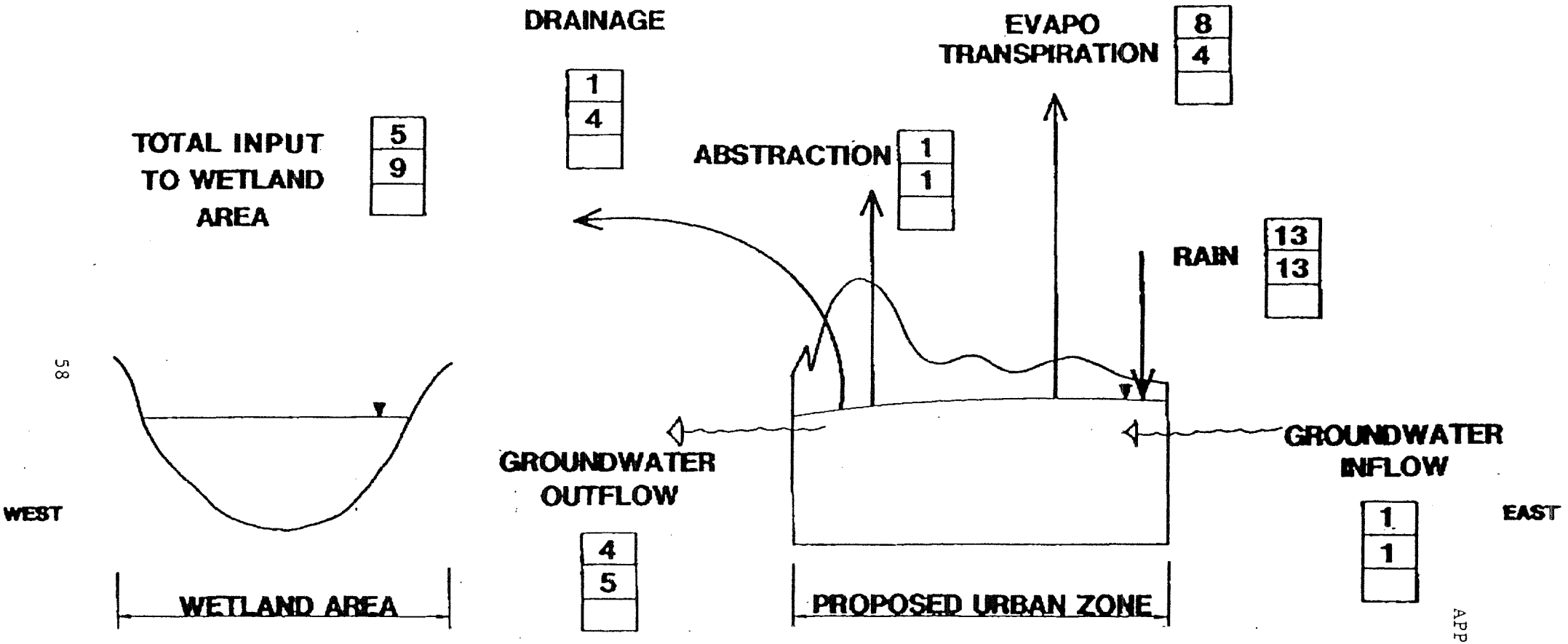
The extent to which this can be achieved is dependent on the aquifer response to pumping, and the quantity of water which can be abstracted without adverse environmental impacts in the region. These matters are currently being investigated as part of preparation of an Environmental Impact Assessment for Stage 2 of the Jandakot Scheme.

The scheme could not be relied upon to reduce drainage flows during sequences of above rainfall years, when scheme operation may be ceased due to preference for use of hills reservoir water.

Stage 2 of Jandakot Scheme is currently planned for commissioning in the mid 1990s.

SIMPLIFIED WATER BALANCE OF DEVELOPMENT AREA

(AVERAGE RAINFALL CONDITIONS)



LEGEND:

ALL COMPONENTS x $10^6 m^3$ p.a.

- EXISTING WATER BALANCE
- PREDICTED WATER BALANCE WITH URBANISATION AND SUBSOIL DRAINAGE SYSTEM

COMMENTS ON THE EAST THOMSONS LAKE URBANISATION PROPOSAL

By David Hedgecock, Convenor of the Urban Design for Water Conservation Research Group, Curtin University of Technology

During the course of researching groundwater management in the Jandakot area (The Hollick Study), a number of contentious issues emerged over the proposal to urbanise a significant proportion of the land overlying the public water supply area.

Of particular concern were the apparently unresolved issues relating to:

- the impact of urban development on the quantity and quality of the underlying groundwater mound;
- the impact of urban development on the adjacent wetlands (Beeliar Park);
- the suitability of traditional subdivision practices in areas of sensitive water balance.

While these factors were duly noted in considering groundwater management options, it was clearly outside the brief of that study to systematically research these matters.

Accordingly, a separate interest group with members from within and outside the Jandakot study was established to discuss the problem and, if possible, to identify possible solutions. In late 1987 this group began to meet and out of the ensuing discussion, three major issues emerged:

(1) The detrimental impact on the environment if the proposed urbanisation over the Jandakot water mound went ahead.

(2) Similar potential impacts that could exist in other parts of the Perth Metropolitan Region.

(3) The nature of action the interest group might take in voicing its concerns and lobbying its ideas.

In November 1987, the Convenor of the group was approached by the Executive Officer of the Western Australian Water Resources Council to investigate the possibility of affiliating the group under the auspices of the Council. This matter was subsequently discussed at a meeting between the Chairman of the Planning and Management Committee and the Convenor at which agreement was reached to further investigate the proposed liaison. In particular, the following matters were to be considered:

- widening of the group's membership;
- drafting of the group's objectives, <u>modus operandi</u> and research programme;
- submission of the above for consideration by Council's Planning and Management Committee.

In February 1988, the following group met to discuss the presentation of a formal research proposal:

David Hedgcock (Convenor)	- Curtin University
Mike Allen	- State Planning Commission (SPC)
Simon Bain	- Town of Mosman Park
John Blyth	- Dept of Conservation and Land Management
Roger Bulstrode	- Water Authority of WA
Alan Hill	- Water Authority of WA
Charlie Nicholson	- Environmental Protection Authority
Jim Singleton	- Environmental Protection Authority

Out of these discussions, draft objectives, organisation and research tasks were established and endorsed by the Planning and Management Committee.

While awaiting financial support, the group met at regular intervals to establish interim policies and principles to ensure input into current planning and development decision-making. A draft interim policy was initially presented at the Swan Coastal Plain Groundwater Management Conference in October 1988. It was later endorsed by the Water Resources Council for submission to the SPC. Discussions are currently taking place between the research group and officers of the SPC to determine its final statutory form.

8.3.1 INTERIM POLICY FOR URBAN DESIGN IN WATER SENSITIVE AREAS

The detail of the policy is as follows:

Residential subdivision design and development should be coordinated with water planning and management in a manner that will:

. Minimise changes to the local and/or regional water balance.

. Achieve water conservation.

. Maintain wetland ecosystems.

. Protect water quality.

. Produce cost effective residential development.

. Enhance local recreational opportunity.

To achieve these objectives developers are required:

. To obtain and analyse the environmental information necessary to achieve integration of land and water planning, (see Environmental Information).

. To prepare plans showing the appropriate urban form, density, landscaping and infrastructure necessary to achieve water sensitive design. (see Design Principles)

. To consider the future management responsibilities, strategies and implications for water sensitive design features (see Management Issues).

ENVIRONMENTAL INFORMATION

The following information should be seen as part of the site evaluation process and will enable design options to be identified on the basis of ongoing water management requirements.

The proponent is required to identify:

- The water balance of the locality and its relationship to the regional water body.
- The expected groundwater rise associated with clearing and urbanisation both on and off the subject site.
- The principal landscape components occurring on the site including:
  - (i) Wetlands, sumplands, damplands and associated vegetation;
  - (ii) Streams, gullies and drainage lines;
  - (iii) Existing or proposed conservation reserves;
  - (iv) Areas of remnant vegetation.
- The significance of these components for conservation, recreation and drainage, and the establishment of criteria to protect their integrity.
- Groundwater availability on the site and the present water quality characteristics, including nutrient levels. The distribution of soil types and their infiltration characteristics.
- The extent of buffer zones around wetlands to accommodate flood storage, nutrient stripping, conservation and recreation.

DESIGN CHARACTERISTICS

The following design principles are intended to assist the development of design solutions associated with determining an appropriate urban form, density, landscape and infrastructure. The application of these principles will be site specific and will be guided by the evaluation of the environmental information obtained for the site.

- Maximise <u>in situ</u> recharge in situations where run off is unpolluted and soil capacity permits.
- Stormwater drainage systems to be designed in a manner that enhances the environmental quality of the site.
- No direct drainage or stormwater discharge to natural wetland systems. Associated sedimentation traps and vegetation buffers to be designed to achieve nutrient stripping.
- Minimise the negative impact of possible nutrient enrichment.
- Where appropriate public open space should be designed developed and managed using Xeric* landscape principles.

* "Xeric - pertaining to an environment containing or characterised by little moisture" The Macquarie Dictionary.

- The boundaries of public open space areas incorporating wetlands to be planned to incorporate vegetation nutrient stripping buffers.

- Urban form and density to be designed in a manner that reduces private open space water demands.

MANAGEMENT ISSUES

The following points should be addressed:

- Appropriate vesting for all reserves.

- Where stormwater compensation basins are incorporated into public open space, suitable vesting and ongoing management responsibilities to be clarified.

- Wetland management and water quality monitoring programmes should be developed, implemented and assessed against established performance criteria.

- An overall landscape plan and management programme to be developed and implemented in accordance with the water sensitive design philosophy of the subdivision.

- Appropriate design and siting guidelines to be prepared to maximise the utility and amenity of private and public open space particularly in higher density areas.

8.3.2 COMMENTS ON LAKE THOMSON URBANISATION PROPOSAL WITHIN THE FRAMEWORK OF THE DRAFT POLICY

ENVIRONMENTAL INFORMATION

GENERAL:

The draft policy seeks to ensure that all relevant environmental information is provided by the proponents at the earliest stages of the planning process to provide a framework for later design and development. In this case too little information has been provided to late to achieve an environmentally sensitive approach to development.

SPECIFIC:

- Water balance and drainage details are now being incorporated into what the proponents believe to be an established urban form. Whereas if this information was available earlier, the urban form (extent) could be determined by environmental constraints, eg land requiring drainage not included in urban zoning.

- No formal assessment of the conservation value of landscape features away from the main wetland chain, eg remnant natural vegetation, seasonal swamps etc.

- Lack of comprehensive analysis of future nutrient levels and their impact upon the surrounding environment.

- While buffer zones around wetlands are proposed, analysis of their nutrient stripping role is simplistic and poorly developed.

DESIGN CHARACTERISTICS

GENERAL:

The subdivision designs currently available (only a small proportion of the total development envisaged) reflect the established standard approach to residential development:

- Exclusively single residential development.
- Average lot sizes of around 700 m^2.
- 15-20 m road widths.
- 10 per cent public open space.
- Piped stormwater discharge to detention basins linked to main drainage.

The policy attempts to move residential development away from this standard model and to encourage innovative approaches to development that will achieve water sensitive design.

SPECIFIC:

. No mix of single residential with other forms of development, eg cluster housing to achieve:

  - reduction in urban sprawl;
  - reduced private open space watering demands;
  - reduced drainage demands.

. No reduction in single residential lot sizes to achieve the same results as above.

. No reduction in road widths to reduce road run off.

. No extension of public open space to reduce drainage demands and increase in situ recharge.

. Lack of innovation to maximise in situ recharge, eg use of road verges for stormwater disposal, retention of all residential run off on site etc.

. Lack of detailed landscape design to achieve nutrient stripping objectives.

MANAGEMENT RESPONSIBILITIES

GENERAL:

The policy aims to clearly establish management roles and responsibilities as part of the planning process as opposed to leaving them to evolve once the development is established. In this proposed development ongoing environmental management is central to the success of the project in such areas as water quality and quantity monitoring, drainage and landscape maintenance etc. However, generally the approach of the proponents is to identify management agencies without detailing management responsibilities, task and liabilities.

SPECIFIC:

- Lack of detail regarding the design and ongoing management of open space areas and in particular their drainage components.

- Details of water quality and quantity monitoring and the required management response are not spelt out.

- No performance criteria established as a framework for ongoing management.

- No overall landscape plan (incorporating management directives) for the development, eg what type of vegetation to be used for nutrient stripping? How to incorporate this into a public reserve? How should it be maintained and managed?

STATEMENT THAT A PROPOSAL MAY BE IMPLEMENTED (PURSUANT TO THE PROVISIONS OF THE ENVIRONMENTAL PROTECTION ACT 1986)

THOMSONS LAKE URBAN STRUCTURE STUDY AND SOUTH JANDAKOT DEVELOPMENT WATER RESERVES MANAGEMENT PLAN

STATE PLANNING COMMISSION
(as proponent for the rezoning under the Metropolitan Regional Scheme)

The proposed urban zoning and Parks and Recreation reservation as generally contained in the Thomson Lake Urban Structure Study Option 1 (Map 10) may be implemented, subject to the following conditions:

1. Prior to the initiation of rezoning and reservation proposals, the proponent shall outline, to the satisfaction of the Minister for Environment a proposal for a drainage management plan for the South Jandakot area, which shall establish a package of mechanisms (including monitoring) to control water levels:

   (1) In the proposed urban areas, which is acceptable to the Water Authority of Western Australia.

   (2) In the Thomson Lake open space area and other wetlands within the proposed Beeliar Regional Park, which is acceptable to the Environmental Protection Authority, Department of Conservation and Land Management and the Water Authority of Western Australia;

   this outline of the proposal shall be made available to the public by the proponent, prior to the rezoning being advertised.

2. Finalisation of the proposed rezoning and reservation shall not occur, until the drainage management plan referred to in condition 1 has been prepared to the satisfaction of the Environmental Protection Authority, Water Authority of Western Australia and the Department of Conservation and Land Management.

3. Once the drainage management plan has been prepared and approved, it shall be progressively and adaptively implemented in parallel with each subdivision stage, including monitoring of the effects of each stage of the drainage management plan. This condition is intended to only require that part of the drainage management plan to be implemented which relates to the portion of land to be subdivided and not for the whole drainage plan to be constructed at once.

   Where the Environmental Protection Authority believes that monitoring shows undesirable environmental impacts are occurring, further stages of the proposal shall not proceed, until changes to the drainage management plan, or development proposal are made to the satisfaction of the Environmental Protection Authority.

4. Prior to subdivisional approval being granted, reporting mechanisms (to the satisfaction of the Environmental Protection Authority, Department of Conservation and Land Management and the Water Authority of Western Australia) for monitoring of the drainage management plan shall be established. These should provide for reporting on the progress of the development, the functioning of the drainage plan and the impact on the wetland eco-systems. The reporting shall be as follows:

   . annual reports

   . detailed review of progress after three years, with decisions to be taken at that time on whether or not and under what conditions further subdivision can proceed.

   These reports shall be submitted by the proponent (or any other agency which has accepted this responsibility) for review to:

   . Department of Conservation and Land Management

   . Water Authority of Western Australia

   . Environmental Protection Authority, and

   with advice from these agencies forming the basis for adjustment or continuation of the drainage management plan.

5. (1) Prior to the finalisation of urban rezoning amendments, the proponent shall provide commitments to the satisfaction of the Minister for Environment, for the reduction in hydrogen sulphide levels associated with the Water Treatment Plant of the Water Authority of Western Australia, to levels acceptable to the Environmental Protection Authority.

5. (2) Prior to subdivisional approvals being granted, the level of hydrogen sulphide emitted by the Water Treatment plant must be reduced to a level acceptable to the Environmental Protection Authority.

6. A buffer area, to the satisfaction of the Environmental Protection Authority (within which residential development shall not occur) shall be established around the existing Water Authority of Western Australia water treatment plant.

   This buffer is required to ensure that:

   - no residential development occurs within the one in one million risk contour associated with chlorine use and storage at the plant;

   - no residential development occurs in areas where levels of hydrogen sulphide associated with the plant are unacceptable to the Environmental Protection Authority for residential uses.

7. Monitoring of groundwater quality shall be undertaken within the groundwater control area by the Water Authority of Western Australia. If undesirable levels of pollution are detected the Environmental Protection Authority may impose conditions on future development in the area. If necessary, controls shall be imposed by the Water Authority of Western Australia on land use practices within the existing urban area.

Barry Hodge, MLA
MINISTER FOR ENVIRONMENT