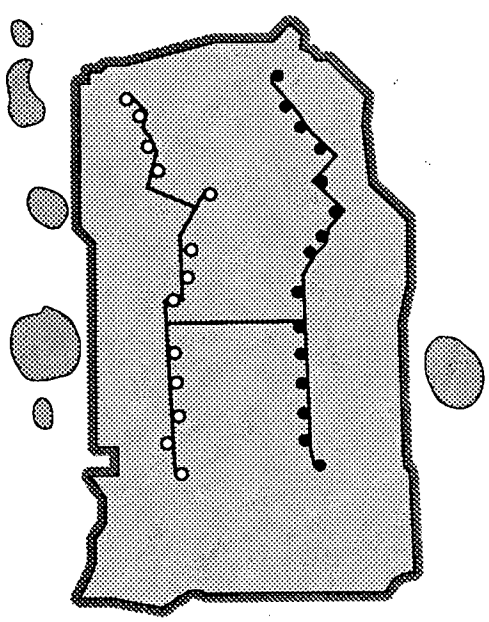
Water Authority
of Western Australia

WATER RESOURCES DIRECTORATE
Groundwater Branch

Jandakot Groundwater Scheme Stage 2
Public Environmental Review

Summary



February 1991

JANDAKOT GROUNDWATER SCHEME — STAGE 2
PUBLIC ENVIRONMENTAL REVIEW

PUBLIC COMMENTS INVITED

The Environmental Protection Authority of Western Australia (EPAWA) invites public submissions on the above project.

This Public Environmental Review (PER) for the further development of the shallow groundwater resource, known as the Jandakot Mound, has been prepared by the Water Authority of Western Australia to meet with the requirements of the Western Australian Government. The proposal is summarised in the Summary Document and described in detail in Volume 1. Technical appendices are included in Volume 2. The PER describes the proposal, examines the likely environmental impacts and discusses the proposed environmental management procedures. The document will be available for comments for eight (8) weeks commencing 28 February, 1990 and closing 25 April, 1991.

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

WHY WRITE A SUBMISSION?

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

All submissions received will be acknowledged.

DEVELOPING A SUBMISSION

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

When making comments on specific proposals in the PER:

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

POINTS TO KEEP IN MIND

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

Attempt to list points so that the issues raised are clear. A summary of your submission is helpful.

Refer each point to the appropriate section, chapter or recommendation in the PER.

If you discuss different sections of the PER, keep them distinct so there is no confusion as to which section you are considering.

Attach any factual information you wish to provide and give details of the source. Make sure your information is accurate.

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

REMEMBER TO INCLUDE

YOUR NAME

ADDRESS

DATE

THE CLOSING DATE FOR SUBMISSIONS IS: 25 April, 1991.

SUBMISSIONS SHOULD BE ADDRESSED TO:

The Chairman
Environmental Protection Authority
1 Mount Street
PERTH WA 6000
Attention: Mr C. Murray

SUMMARY

INTRODUCTION

This Public Environmental Review (PER) contains an overall approach to the management of groundwater abstraction from the Jandakot Mound and describes the Water Authority's proposal to expand public groundwater abstraction. The PER serves two main purposes:

- it enables the EPA to assess the proposal and provide its advice to the Minister for the Environment who will judge the environmental acceptability of the proposal, and
- it provides the public with further information about the proposal with an opportunity to provide feedback as to whether the Water Authority has satisfactorily balanced the benefits of an expanded public and private water supply with protection of the environment and community expectations. The Water Authority now seeks agreement of the Minister for the Environment to the implementation of the proposed Stage 2 expansion of the Jandakot Groundwater Scheme.

The proposed management of groundwater abstraction presented in this report is one of a number of management issues currently being developed for the Jandakot area; these include the proposed Beeliar Regional Park and Jandakot Botanical Park. The boundaries of the Beeliar Regional Park have been proposed, a planning study has been released (DPUD, 1990) and a management plan will soon be developed. Neither the boundaries nor the management of the Botanical Park have been resolved. The Water Authority considers the formalisation of both Park proposals as integral to the development of a cohesive management plan for the Jandakot area and is supportive, in principle, of both proposals.

THE JANDAKOT GROUNDWATER SCHEME

The Water Authority of Western Australia is responsible for providing water services and managing the State's water resources for the benefit of the whole community. This includes the allocation of groundwater resources for public, private and environmental uses. The Water Authority is also responsible for providing scheme water for public supplies at least cost, subject to social and environmental objectives.

Groundwater makes up half of the available water resources of the Perth-Mandurah region and provides a third of the Metropolitan scheme water supplies.

The term groundwater refers to water stored in the spaces between sand grains and pebbles, and in rock fissures. Groundwater can be divided into shallow (superficial) and artesian (confined) groundwater. Shallow groundwater is found in the sandy layer, or aquifer, which covers much of the coastal plain around Perth, which can be up to 100 metres deep. It is recharged by rainfall which drains through the sand. Artesian groundwater is found confined between impermeable, or very low permeability layers in the soil profile and is usually replenished some distance away where the aquifer is in contact with shallow groundwater.

In the Jandakot area, the shallow groundwater resource is referred to as the Jandakot Mound. This is due to the variation in the height of the water table in the area. The water table is higher in areas of higher ground and in cross section gives the groundwater the appearance of a large mound.

Development and operation of the Jandakot Groundwater Scheme (GWS) began in 1979 with the commissioning of Stage 1. At that time approval was also given for Stage 2. However, due to the period of time that has passed since commissioning Stage 1, the Water Authority has decided to refer the proposal for Stage 2 back to the EPA for reassessment.

Stage 2 of the Jandakot GWS involves establishing a line of 13 wells in the superficial aquifer, collectively termed a wellfield, to the west of the existing Stage 1 wellfield (Figures 1 and 2). The wells will be connected by a collector main which will feed into the existing Stage 1 collector main. The collector main, which will be 0.2 to 0.6 metre in diameter and buried at a depth of 0.9 to 1.4 metres, will deliver the groundwater to an existing Water Treatment Plant (WTP) for chlorination, fluoridation and removal of iron. The WTP will be upgraded to accommodate the extensions. This will not require any change to the boundaries of the WTP. The treatment process will remain unchanged except for a switch from the use of gaseous chlorine to liquid chlorine which will improve the safety of the WTP. In addition to the above 'public' abstraction, it is also proposed to allow for an increase in private groundwater abstraction.

This proposal considers the total use of the groundwater resource, that is the combined effect of public and private abstraction on both the water resource and the environment.

Public Abstraction

Under the Stage 2 development, public water supply abstraction from the shallow aquifer will be increased from 4 to 8 million cubic metres per year by adding a new line of wells to the west of the existing wellfield.

Private Abstraction

Groundwater of the Jandakot Mound is valuable as a source of private water supply for many uses including horticulture, gardens, industry and parks.

Under this proposal, private abstraction will be permitted to rise from 9 to 16 million cubic metres a year over a period of time. This is expected to be sufficient to meet the long term demands of most private users.

THE NEED FOR PUBLIC ABSTRACTION

Details of the historic and projected demand for water from the Metropolitan Water Supply Scheme (MWSS) can be found in the report 'Planning Future Sources for Perth's Water Supply (1989 Revision)' (WAWA 1989a). From past records, it has been determined that the 'most likely' demand projection on the MWSS will be an annual increment of 2% while the 'maximum' demand will be an annual increment of 3.5%. Under the current sources development timetable, Jandakot GWS Stage 2 extensions will be required by October 1993 to meet this 'most likely' demand, and by October 1992 for the 'maximum' demand. Planning is proceeding on the basis of meeting the earliest timetable.

The Water Authority believes that the Jandakot GWS Stage 2 is among the most cost effective sources available for development and can be developed without unacceptable environmental impacts. No other planned sources could currently be developed for a similar cost that would result in a reduced overall environmental impact for the MWSS.

THE NEED FOR PRIVATE ABSTRACTION

The sources of private demand for water in the Jandakot area are urban demand, special rural demand, rural demand and industrial demand. Increases in demand are expected for all of the private 'users'. Proposed amendments to the Metropolitan Region Scheme, could increase urban land in the Jandakot Public Water Supply Area (PWSA) from 5% to about 20%. Associated with this will be increased domestic water use, private groundwater wells and wells for irrigation of public open space. Increased demand is also expected from the special rural, rural and industrial sectors.

THE ENVIRONMENT — BACKGROUND

The Jandakot Mound area supports remnant wetlands and *Banksia* woodlands which depend on the shallow groundwater resource. In turn, the wetlands and vegetation support a range of fauna which is highly valued by the community. Parts of the area have visual and recreational value and the area as a whole contributes significantly to conservation locally, regionally and internationally.

In a 1987 report (WAWRC, 1987), the Western Australian Water Resources Council listed North, Bibra, Yangebup, Thomsons, Banganup and Forrestdale Lakes and The Spectacles as wetlands of regional to international significance. Both Thomsons and Forrestdale Lakes have since been listed as Ramsar wetlands under an international treaty. Le Provost et al. (1987) also listed a number of other wetlands in the area of potential significance including, Twin Bartram, Solomon Rd, and Bartram Rd wetlands.

All these wetlands are surface expressions of the groundwater system and, therefore, have water levels that fluctuate with water table fluctuations. The shallow groundwater of the Jandakot Mound is recharged directly from rainfall. The quantity of recharge depends on rainfall, evaporation and water use by vegetation, all of which follow a seasonal pattern. Other factors contributing to the fluctuations in water level are leakage/outflow of groundwater, groundwater abstraction and drainage systems around the wetlands. The water balance of a wetland is depicted schematically in Figure 3. The cumulative effect of these processes is a seasonal fluctuation in wetland and groundwater levels as well as a longer-term response to rainfall trends. The plants and animals of the Jandakot Mound area are adapted to this regime of fluctuating groundwater levels.

In the Jandakot area there are proposals for a Regional Park (Beeliar) and a Botanical Park for conservation and recreation, as mentioned earlier, as well as impinging urban areas and proposals for further urban development.

The above factors have resulted in a complex and dynamic situation where the groundwater provides for many functions which contribute to the quality of life of the community. This environmental impact assessment approaches protection of the environment by identifying the components and functions of the environment supported by the shallow groundwater regime.

PROTECTION OF THE ENVIRONMENT

Protection of the environment has been addressed in this PER through a system of criteria. Firstly, interim criteria were established to protect the components and functions of the environment which were identified as being supported by shallow groundwater. The groundwater scheme described in the PER has been subsequently developed to ensure that the criteria are met while optimising the amount of groundwater that can be

abstracted. It was not possible to address every aspect of the environment since there was a lack of detailed information for many components. The approach taken therefore, was to concentrate on the wetlands of the region for which sufficient data were available. It has been assumed that by protecting these sensitive components of the Jandakot area most other components will also be protected. Many independent studies were sponsored by the Water Authority to provide information that was used as a basis for setting criteria.

Because of the dynamic nature of the Jandakot area, criteria will need to be updated as the area changes and as our knowledge of it improves. The criteria take into account the community's expectations of the way in which the Water Authority should manage water and the environment associated with water resources. Management is based on the concept of sustainable yield, utilising only that part of a water resource that can be replenished and is therefore available in perpetuity. The groundwater scheme is designed to provide as large a water supply as possible without unacceptably affecting the private and public users and the environment and without compromising the environmental criteria or the water resource.

The criteria are developed as design, operational and action criteria. Design criteria apply at the design phase. Operational and action criteria are the desirable and essential criteria to be adhered to, respectively, in the operational stage of the scheme. The criteria address the following broad categories:—

- terrestrial habitats,
- major wetlands,
- the wetlands as a system, and
- air quality.

Terrestrial Habitats

Terrestrial habitats' criteria cover well location, general drawdown of the water table, drawdown in areas of rare flora and System Six areas, and seasonally inundated wetlands. They are intended to protect sensitive vegetation from rapid or unacceptable drawdowns in the water table level that could result in death of vegetation or significantly altered conditions for the biota dependent on that vegetation. They specify the maximum permissible drawdowns of the water table in the environmentally sensitive areas listed above and the distances that wells must be removed from these areas. Environmentally acceptable work practices are established for the construction phase of the proposal to prevent avoidable impacts.

The Major Wetlands

The major wetlands for which detailed criteria are set are Thomsons, Forrestdale, Yangebup, North, Bibra and Kogolup Lakes. These criteria set water levels which must be maintained for each of the wetlands and are based mainly on EPA and CALM recommendations for the wetlands. They are set to protect the functions and components of the wetlands that have been identified as important.

The environmental values attributed to North, Bibra and Yangebup Lakes were used to develop the management objectives in Table 1 and the criteria in Table 2 (pt 18). The criteria for Thomsons Lake (Table 2, 9-12) were based on CALM's desire to see, among other things, lower water levels in the lake. Criteria for Forrestdale Lake (Table 2, 13-17) were based on CALM's

Table 1 Detailed objectives for North, Bibra, Yangebup and Kogalup Lakes.

LAKE	DETAILED OBJECTIVE
NORTH	• have *Melaleuca* spp. periodically inundated • stay within historical water level range • maintain aesthetics
BIBRA	• limit Typha spread • have *Melaleuca* spp. and mudflats periodically inundated • stay within historical water level range • maintain aesthetics • maintain access to recreation areas (avoid flooding) • maintain as a summer refuge for waterbirds
YANGEBUP	• limit Typha spread • have *Eucalyptus rudis* (flooded gums) periodically inundated • stay within historical water level range • maintain aesthetics • avoid flooding • maintain as a summer refuge for waterbirds
KOGOLUP	• stay within historical water level range • have *Melaleuca* spp. periodically inundated • maintain as a summer refuge for waterbirds

recommendation that the lake have at least 0.9 m of water in it at the time of maximum water level and a natural cycle of filling and drying, as well as some additional criteria specifying the preferred time of drying for years of various rainfall levels.

The Wetland System

The wetlands are protected as a system by specifying maximum acceptable habitat shifts based on the interrelationship between the wetlands. This recognises the importance of the diversity in habitat types that makes the Jandakot area a significant conservation zone.

The permissible shifts are expressed as percentages of the original habitat area and cover both loss and gain of habitats for different rainfall-type years. A wet year is one with total rainfall that places it in the wettest 10% of years on record. A dry year is one with total rainfall that places it in the driest 10% of years on record. A medium year is one with rainfall levels within the range recorded for the other 80% of years. The actual rainfall values associated with these categories will vary depending on the rainfall levels during the climatic period used to calculate them.

The habitats were classified on their importance to waterbirds, since these were considered suitable indicators of habitat value. Thirteen habitat classes were grouped into one of four habitat types on the basis of a habitat sensitivity analysis. This analysis took into account the value of the habitat as a breeding, feeding and loafing area for waterbirds and then gave it a ranking of Class I (a habitat that species of waterbirds would be most sensitive to change in) to Class IV (least sensitive to change in). The classification was applied separately to common species and to rare species of waterbirds.

Following consultation with CALM, the following shifts were recommended:—

- 5% was recommended as the maximum allowable reduction for a Class I habitat in a wet year
- from a dry to a wet year the maximum allowable reduction of habitat can increase by 10% within a Class
- from Class I to Class IV the reduction of habitat allowed can increase by 10% within any rainfall group.

This resulted in the allowable shifts listed in Table 2 (criterion 19).

Thomsons Lake is not considered for the purposes of determining habitat shifts. This is because shifts will probably occur in accordance with CALM's criteria to enhance the value of Thomsons Lake as a waterbird habitat. This favours lower water levels in the lake than those experienced over the past 10 years and habitat shifts associated with those lower levels. Since the effect of the groundwater scheme will be to slightly reduce water levels in Thomsons Lake, any associated habitat shifts are considered to be in line with the proposed management strategy.

Air Quality

Air quality criteria are set to minimise odours from hydrogen sulphide and to minimise the health risk from chlorine gas. Buffer zones, allowable concentrations and permissible health risks are established in the criteria and are based on EPA and other established criteria.

A complete list of the environmental criteria is presented in Table 2.

THE PREFERRED OPERATING STRATEGY

A computer model was used to simulate the effects of different management scenarios on groundwater levels in the Jandakot area. Three scenarios were modelled based on the current and expected land and water resource uses in the area.

These are:

Scenario 1 The current situation — using current land-use practices and abstraction;

Scenario 2 The short-term future situation without urbanisation — using proposed land-uses and public and private abstraction, but not incorporating proposed urban development;

Scenario 3 Longer-term future situation with future land-use, including urbanisation, public and private abstraction.

The climatic record for the past 75 years was used in modelling the three scenarios to gain an indication of expected water levels for each scenario under climatic conditions similar to those experienced in the past.

The model was used to vary the location of the proposed Stage 2 wells and a strategy was developed which optimised the groundwater abstraction pattern and adherence to the interim criteria. This ensures there are minimal effects on sensitive wetlands and upland vegetation of the Jandakot area. The strategy also results in minimal competition with private water users. The predicted changes in water levels for Scenario 3, the long-term land-use and water abstraction scenario, are shown in Figure 4.

Table 2 Summary of the terrestrial, wetland and air criteria.

TERRESTRIAL

Design criteria

1 Wells should not be placed closer than 300 metres to natural non-degraded sumplands (seasonally inundated wetlands) and preferably not closer than 500 metres.

2 Drawdowns must not exceed 1 metre in areas of phreatophytic native vegetation.

Action and Operational criteria

3 Wells shall not be placed closer than 200 metres to System Six area M94 and preferably not closer than 400 metres as a design criterion.

4 Any well whose drawdown cone is estimated to be greater than 1.5 metres deep in environmentally sensitive areas will have its draw phased in evenly over a three year period.

5 Actual drawdowns should be less than 1 metre in areas of phreatophytic native vegetation and in no case shall exceed 1.5 metres.

6 In areas where rare species of orchids are known to occur, drawdowns should be less than 0.5 metre and must be less than 1.0 metre.

7 The Bartram Road Wetland Complex and Twin Bartram Swamp should preferably contain water until the end of January.

8 Water table drawdown in Beenyup Road Wetland and Solomon Road Wetland should preferably be less than 0.3 metre.

THOMSONS AND FORRESTDALE LAKES

Thomsons Lake

Design criteria

9 Water levels in Thomsons Lake must satisfy those given in Table 7.2 for at least 30% of years (i.e. be an improvement on the present situation).

Operational and Action criteria

10 The average annual deviation over a four year period from the predicted water levels in Thomsons Lake must not be greater than 0.1 metre.

11 Should the deviation between the actual and predicted minimum water level in Thomsons Lake exceed 0.25 metre in any one year, this must be reported to the EPA as soon as possible, and

12 The minimum water level at Thomsons Lake must never go below 10.8 metres AHD.

Forrestdale Lake

13 At least 0.9 metre of water in the lake when water levels are at their annual maximum (the deepest point is at 21.6 metres AHD), and

14 A natural cycle of filling and drying should be allowed to continue.

15 Minimum water levels should be in the range 21.2 - 21.6 metres AHD.

16 Minimum water levels shall be greater than 21.1 metres AHD.

17 The preferred times of (earliest) drying are:

WET YEARS	dry by April
MEDIUM YEARS	dry by February-March
DRY YEARS	dry by January.

MAJOR WETLANDS

18 The recommended water level maxima, operational minima and action minima for the major wetlands are:

	RECOM-MENDED MAXIMA	OPERAT-IONAL MINIMA	ACTION MINIMA
North	< 14.9	13.0-13.5	12.7
Bibra	< 15.0	13.6-14.2	13.6
Yangebup	< 16.5	13.9-15.5	13.8
Kogolup	< 14.8	13.1-14.0	13.1
Banganup		11.5	

THE WETLAND SYSTEM

19 The maximum allowable habitat reductions (as percentages in area) for the Jandakot Area (Thomsons Lake excluded) are:

HABITAT TYPE	WET YEAR	MEDIUM YEAR	DRY YEAR
I	5	10	15
II	8	13	18
III	12	17	22
IV	15	20	25

20 Increases of habitat shall be no more than 5% greater than the values given in the above table.

21 Bibra Lake must not dry out for more than 2 years in any 3 year period, and preferably not more than 1 in 3.

22 Either Bibra Lake or Yangebup Lake must contain 0.3 metre of water and preferably 0.5 metre.

AIR QUALITY

Chlorine

23 A buffer zone be maintained around the chlorine storage area of the treatment plant, and

24 The treatment plant and chlorine handling be operated in the manner described in section 4, resulting in a level of personal risk of fatality of no greater than one in a million in any year at the buffer zone boundary.

Hydrogen sulphide

25 A buffer zone be established with the distance defined by an anticipated hydrogen sulphide concentration of 5 parts per billion averaged over 30 minutes, as calculated for atmospheric conditions of Parquille class F and 2 metre per second wind velocity.

ENVIRONMENTAL IMPACTS

Under this proposal groundwater levels will generally decrease by between a few centimetres and one metre depending upon the location, and will be within the interim criteria. The greatest drawdowns will be confined mostly to the less sensitive areas of the terrestrial environment. Impacts associated with the Stage 2 extension can be divided into several broad groups, these being:

- construction,
- air quality,
- terrestrial,
- wetlands, and
- social issues.

Impacts are assumed to be acceptable if the environmental criteria are satisfied.

Construction

Of the 13 superficial wells, most will be located in areas already cleared or disturbed by road-works. The total loss is less than one hectare. The extent of disturbance will be minimal as drilling and wellhead establishment crews will confine their activities to the immediate vicinity of the wells.

The majority of the collector mains pass through disturbed areas such as road reserves. At no point will the collector mains traverse large areas of undisturbed native vegetation.

Rehabilitation will follow construction, as necessary, with the objective of returning the areas, other than access tracks, as closely as possible to their original condition.

No new impacts shall result from extensions to the WTP. Once the on-site works are completed, the extensions to the treatment plant will not be visible from the adjacent road reserve. Some additional landscaping is proposed in the vicinity of the aerators.

Air quality

Changes to the operating system to be introduced prior to commissioning Stage 2 will further reduce the probability of a chlorine leak at the WTP. A buffer zone is recommended to ensure compliance with the EPA's prescribed personal risk level of less than 1 in 1 million fatalities per annum.

The hydrogen sulphide levels experienced within the recommended 400 metre buffer zone will be noticeable and even offensive at times. The levels however present no danger to health. Outside the buffer zone, levels of hydrogen sulphide released during operation of the Treatment Plant will not be noticeable.

Terrestrial

The impacts on remnant vegetation and rare orchids are considered acceptable because the criteria to protect these will be satisfied. It is expected that lowering the water table under vegetation by no more than 1.5 metres will not result in tree deaths and will have no appreciable effect on other deep-rooted plants except possibly to reduce transpiration rates. In some areas there may be a slight and gradual shift in the vegetation towards species more tolerant of dry soil conditions.

The criteria for the protection of the rare orchids, such as the donkey orchid (*Diuris purdiei*), are satisfied, and as such, the impact will be minimal.

No measurable impacts on the terrestrial fauna are anticipated except where they are linked to the composition of the understorey vegetation. Again, the changes in vegetation are expected to be small.

Wetlands

The criteria have been complied with for the major wetlands. As such, the impacts of the scheme on these wetlands are considered acceptable. The impacts of the project will be beneficial in assisting to reduce artificially high water levels in some wetlands, particularly North, Bibra and Yangebup Lakes. The end of summer changes in water levels for the major wetlands and the relative contributions of changes in land use, public abstraction and private abstraction are shown in Table 3.

It should be noted that the total effect is not always the sum of the three influences. It should also be noted that these represent the long-term effects and are expected once the public water supply scheme and the private draw are fully developed. In the short to medium-term the effects should be less than indicated in Table 3, allowing a period for monitoring and review of management. The drawdowns indicated are likely to occur at the end of summer and should be less at other times of the year.

This is because of interactive effects on the rates of evapotranspiration, diversion of rural drains and other factors which cumulatively act to reduce the total effect.

Rigorous criteria have not been developed for Banganup Lake and The Spectacles due to the lack of detailed information including bathymetry. Considering the pristine nature and importance of Banganup Lake, and the modelled effect of the most likely scenario (scenario 3), the predicted impact is unlikely to be acceptable. Much of this impact is unavoidable if groundwater levels are

Table 3 Predicted changes in water level in wetlands due to changes in land use, increasing private abstraction, and public abstraction.

WETLAND	LAND USE	PRIVATE	STAGE 2+ JAND. SOUTH	TOTAL
		(all in metres)		
NORTH	0.05	-0.10	-0.05	-0.10
BIBRA	0.20	-0.45	-0.20	-0.50
YANGEBUP		main impact due to water level control		
KOGOLUP		main impact due to water level control		
FORRESTDALE	0.00	-0.10	0.00	-0.10
THOMSONS	0.20	-0.10	-0.05	-0.50
BANGANUP	0.10	-0.05	-0.05	-0.20
THE SPECTACLES	0.05	-0.15	-0.15	-0.15
BARTRAM RD COMPLEX	0.15	-0.20	-0.25	-0.15
BEENYUP ROAD	0.30	-0.30	-0.20	-0.25
TWIN BARTRAM	0.50	-0.80	-0.70	-0.90
SOLOMON ROAD	0.55	-0.75	-1.25	-1.10

managed in accordance with CALM's desire for lower water levels in Thomsons Lake.

Artificial maintenance is clearly an option to mitigate the effects of drawdown on Banganup Lake. It is proposed that the Water Authority, in conjunction with CALM and the University of WA, undertake a study to establish detailed criteria for the lake and consider the effectiveness of artificial maintenance.

Water levels in The Spectacles may be affected by drawdown due to increased groundwater abstraction by public and private users. Water levels will be closely monitored and opportunities for active management examined should this be considered necessary.

The recommended criteria for the wetlands are based on maintaining fringing native vegetation. As these criteria are satisfied, the impacts on native fringing, aquatic and emergent vegetation of the major wetlands in the Jandakot Area are expected to be minimal.

Criteria have been recommended to ensure that waterbird breeding and feeding habitats are maintained and that important refuge areas (Forrestdale and Thomsons Lakes) are protected. These criteria have been satisfied and as such the environmental impacts are considered acceptable.

For some wetlands, lowering water levels is likely to lead to an increase in habitat diversity which in turn will lead to increased species diversity of macro-invertebrates.

In those instances where a wetland dries out, midge numbers and odour problems will be reduced considerably.

The average (ie end of winter) nutrient status of the wetlands will not be altered. For seasonal wetlands, the scheme may bring forward the time of drying, and the timing of any evapoconcentration of nutrients, to earlier in the summer. However, there will be no additional evapoconcentrative effect due to groundwater abstraction in the vast majority of the seasonal wetlands.

Up to six damplands (waterlogged areas) will be significantly degraded. These have a total area of less than 0.2 square kilometres. Assuming that the South Jandakot Urban Development proceeds, three of these damplands would be cleared and urbanised. The significant sumplands meet the criteria apart from Twin Bartram Swamp and Solomon Road Wetland.

It is likely that Twin Bartram Swamp would need to be artificially recharged to meet the criteria. The Water Authority has commenced water level monitoring in Twin Bartram Swamp and will commission a hydrogeological study.

Impacts on Solomon Road Wetland are likely to include:

- water levels being lowered by up to 1.25 metres,
- the South Jandakot Urban Development, and
- the southward extension of the Kwinana Freeway.

Due to these impacts Solomon Road Wetland will have major changes to the structure and composition of its vegetation. Most fauna will cease to use the area.

It is unlikely that the environmental values of Solomon Road Wetland can be maintained due to the number and range of likely impacts. However, should it appear that these values are maintained despite urbanisation, the Water Authority shall examine options for actively managing water levels in the wetland.

Social

The social impacts of Stage 2 should, in general, be minimal.

It is recognised that there is more active and managed recreation in the north of the Jandakot Area, especially around North Lake and Bibra Lake, and more passive recreation and use related to conservation values in the south, particularly around Thomsons Lake.

Water abstraction from the mound will be regulated to maintain historical water levels in the lakes. Because Bibra Lake's aesthetic and recreational importance is so great, the lake's action minimum water level was set at 13.6 metres AHD, higher than its environmental action minimum, 13.3 metres AHD.

Implementation of the scheme will improve recreational use of Bibra and North Lakes by reducing the risk of flooding of recreational facilities and roads.

The overall impact of lowered water levels on the recreational use of the wetlands will be minimal due to most of that recreational use being independent of water levels.

It is expected that the impacts on land use due to this proposal will be minimal as the Jandakot wellfields area has been declared an Underground Water Pollution Control Area (UWPCA) and a PWSA for over 15 years.

PUBLIC INVOLVEMENT

The Water Authority supports public involvement in decision making where complex judgements and community attitudes are important. Public involvement in relation to this environmental impact assessment included:

- meetings with a discussion group representing various community interests;
- an open day at the Jandakot Water Treatment Plant;
- encouraging the publication of newspaper articles promoting an understanding of groundwater; and
- an essay competition on groundwater for school children.

Responses from recent questionnaires on groundwater and environmental issues were taken into account.

There has also been extensive consultation with Government agencies which have responsibility for land planning and management.

MANAGEMENT COMMITMENTS

Apart from undertaking to ensure that groundwater abstraction is in compliance with the environmental criteria, thirty-seven commitments are given. These commitments are listed in Table 4 and mainly relate to management of water levels, water conservation, management of private abstraction, land use management, project construction, expansion of the groundwater treatment plant, the monitoring programme and reporting mechanisms. The Water Authority will report to the EPA and to a consultative groundwater committee annually on the results of monitoring and management. The consultative committee will have representatives from various local community interest groups and Government agencies.

Table 4 Environmental Management Commitments

NO	COMMITMENT
1	To prepare a Management and Monitoring Programme, satisfactory to the EPA, prior to commissioning of the Stage 2 Scheme.
2	To ensure that groundwater abstraction satisfies the environmental criteria presented in this PER.
	To mitigate impacts associated with construction of the Stage 2 Scheme the Water Authority will ensure:
3	• clearing of vegetation at well sites will be restricted to the area of the enclosure (approximately 25 metres square) in non-urban areas, and the immediate area of the well head in the case of wells located in public open space in urban areas,

Table 4 Environmental Management Commitments — *continued*

NO	COMMITMENT
4	• where practical the collector main will be located within existing road reserves
5	• on Crown Land, top-soil from the collector main trench will be separately stripped, stock-piled and re-spread on completion of pipe laying,
6	• on private land, the collector main route will be left in a state agreed to by the land owner/occupier,
7	• where feasible, well site compounds will be used for the storage of materials and for contractors' facilities, in preference to the establishment of separate short-term sites,
8	• where temporary construction sites are established, the area will be returned either to its original state, in the case of Crown Land, or to a state agreed to by the land owner/occupier,
9	• all work on extensions to and modifications of the Jandakot Treatment Plant will be undertaken on existing cleared areas within the boundary of the Plant site, and
10	• all workers involved in project construction in natural areas will be instructed on environmental protection procedures before work proceeds.
11	In the event that monitoring indicates that there will be significant impacts of a nature not predicted in this evaluation or a breach of the specified criteria, then as discussed in sections 6.9 and 7 the Water Authority must undertake one or more of the following: • demonstrate to the satisfaction of the EPA that the breach in criterion is not a result of groundwater abstraction, or • satisfy the EPA that the breach of criterion is transient and not of permanent significance, or • take the relevant action as specified in section 7: — modify pumping from any well where such changes can have a measurable effect (say raise water levels 1 centimetre or more), except in extenuating circumstances such as where significant economic hardship would occur, or CALM declare that the low water levels would be beneficial, — in the case of a wetland, artificially maintain the 'action minima' water level (see Table 7.5), and — implement a short-term detailed monitoring programme to establish the condition of agreed species in the affected area.
12	To modify the chlorine withdrawal system to a liquid process prior to commissioning of the Stage 2 line of wells.
	To operate the treatment plant so that within a 500 metre buffer zone:
13	• the personal risk hazard of fatality associated with chlorine release is less than one in a million in any year, and
14	• hydrogen sulphide levels attributable to plant operation will be below noticeable levels of 5 parts per billion.
	To continue to manage private water abstraction by:
15	• regularly reviewing the bulk allocations for private abstraction, as part of the total water abstraction allocation for the Jandakot PWSA, with regard to the sustainable yield of the superficial aquifer, including consideration of the environmental impacts of that abstraction,
16	• restricting the issuing of licences for private water abstraction to the limits set by the bulk allocations, for both the Jandakot PWSA in its entirety and the licensing sub-areas, and
17	• investigating and implementing efficient mechanisms for groundwater allocation.

Table 4 Environmental Management Commitments — *continued*

NO	COMMITMENT
18	• Conduct pump tests on Stage 2 wells and liaise with nearby private users of groundwater prior to commissioning to assess the impact of Stage 2 wells on private wells.
	To protect the groundwater resource by active participation in:
19	• the development of Environmental Protection Policies to protect groundwater,
20	• the review of Regional Plans proposed by the Department of Planning and Urban Development, Local Government Town Planning Schemes, and rezoning and development applications, and
21	• the review of development submissions to the EPA.
22	To work with the Department of Planning and Urban Development to prepare an integrated Land Use and Water Management Strategy for the Jandakot Mound.
23	To actively pursue programmes in both supply and demand management. This includes ongoing public information programmes and, where appropriate, regulation for design changes and regular reviews of pricing to conserve water. Improvements in the Authority's supply system will also be pursued.
24	To actively participate in integrated management of the Jandakot catchment.
25	To review the management criteria and strategies, with the agreement of the EPA, as knowledge of the Jandakot environment and its interaction with groundwater improves.
26	To review opportunities for reducing the radius of the buffer zone required around the treatment plant to achieve acceptable personal risk and hydrogen sulphide levels.
27	To monitor water levels in groundwater monitoring wells and North, Bibra, Yangebup, Kogolup, Thomsons, Forrestdale Lakes, The Spectacles and Twin Bartram Swamp, as well as some other small wetlands.
28	To monitor vegetation transects on a triennial basis to establish significant changes in the condition, floristics or structure of vegetation communities.
29	To continue to fund the research projects listed in Appendix 2 for the duration of the studies.
30	To use aerial photographs on a triennial basis to detect habitat shifts in North, Bibra, Yangebup, Kogolup, Thomsons and Forrestdale Lakes.
31	To develop a fauna monitoring programme, prior to the commissioning of the Stage 2 Scheme, which will focus on: • waterbird species diversity and breeding success, and • number of families of aquatic invertebrate and at infrequent intervals, species richness.
32	To hold meetings at least annually with a Jandakot Consultative Committee which will be established in consultation with the EPA. This Committee will be informed on the scheme's operation and will provide feed-back to the Water Authority.
33	To continue to monitor community response as reported by the media and maintain the current practice of public accessibility of Water Authority officers. Upon request and adequate notice, officers will address community groups on issues associated with groundwater management.
34	After the commissioning of the Stage 2 Scheme, written reports to the EPA will consist of: • annual reports addressing compliance with the environmental protection criteria, and • triennial reports including, in addition to a review of compliance with the criteria, an evaluation of the effectiveness of the criteria in meeting the environmental protection objectives.

Table 4 Environmental Management Commitments — *continued*

NO	COMMITMENT
35	To advise the EPA immediately upon becoming aware that specific environmental protection criteria might be breached. Details of the actions taken to avoid such a breach of criteria, or in the event of a breach occurring, its consequences, will be reported to the EPA at the earliest feasible date.
36	Undertake a study of Banganup Lake, in conjunction with CALM and the University of WA, to establish management criteria and consider the effectiveness of artificial maintenance of water levels.
37	Undertake a study of Twin Bartram Swamp to consider the feasibility and effectiveness of artificial maintenance of water levels.

CONCLUSIONS

This proposal has been arrived at by a process of scientific investigation and community consultation. Community input has come from numerous sources and the release of this document now permits even wider public input to the planning and decision making process. Public feedback to the Water Authority and the Environmental Protection Authority is important, particularly in making the ultimate judgement as to whether or not this proposal accommodates the various community needs and expectations.

The Water Authority considers that the proposed scheme recognises the multitude of uses and values for the groundwater resource and makes the best sustainable use of that resource. As knowledge of the complex hydrological, social and ecological system increases with time, the balance of water allocated to the various uses and the way in which it is utilised will certainly evolve. The present proposal is believed to make best use of the resource within the current limits of our confidence to manage the groundwater regime and not cause significant or irreversible changes.

REFERENCES

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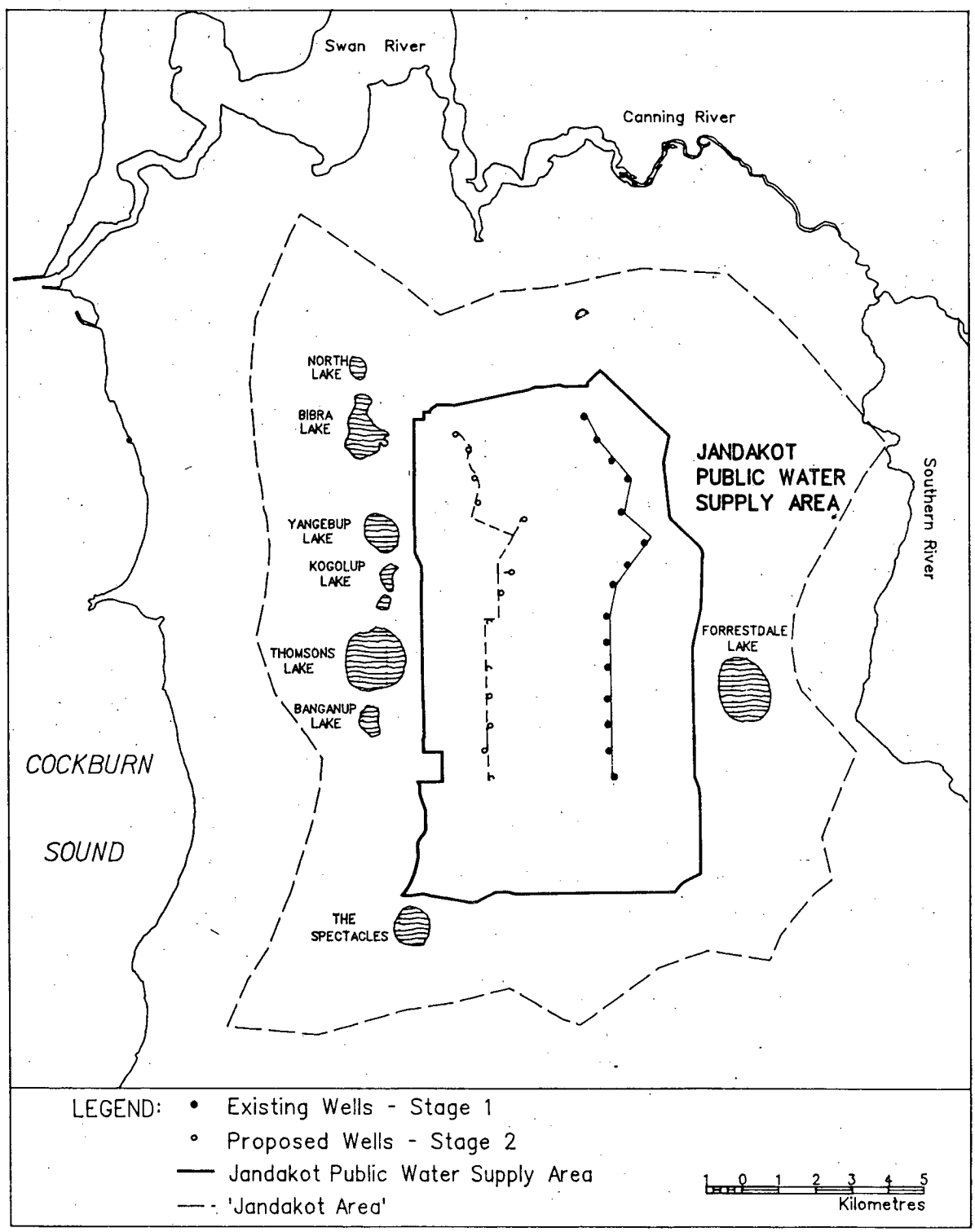

Figure 1: Location of Public Water Supply Area and existing and proposed public water supply wells.

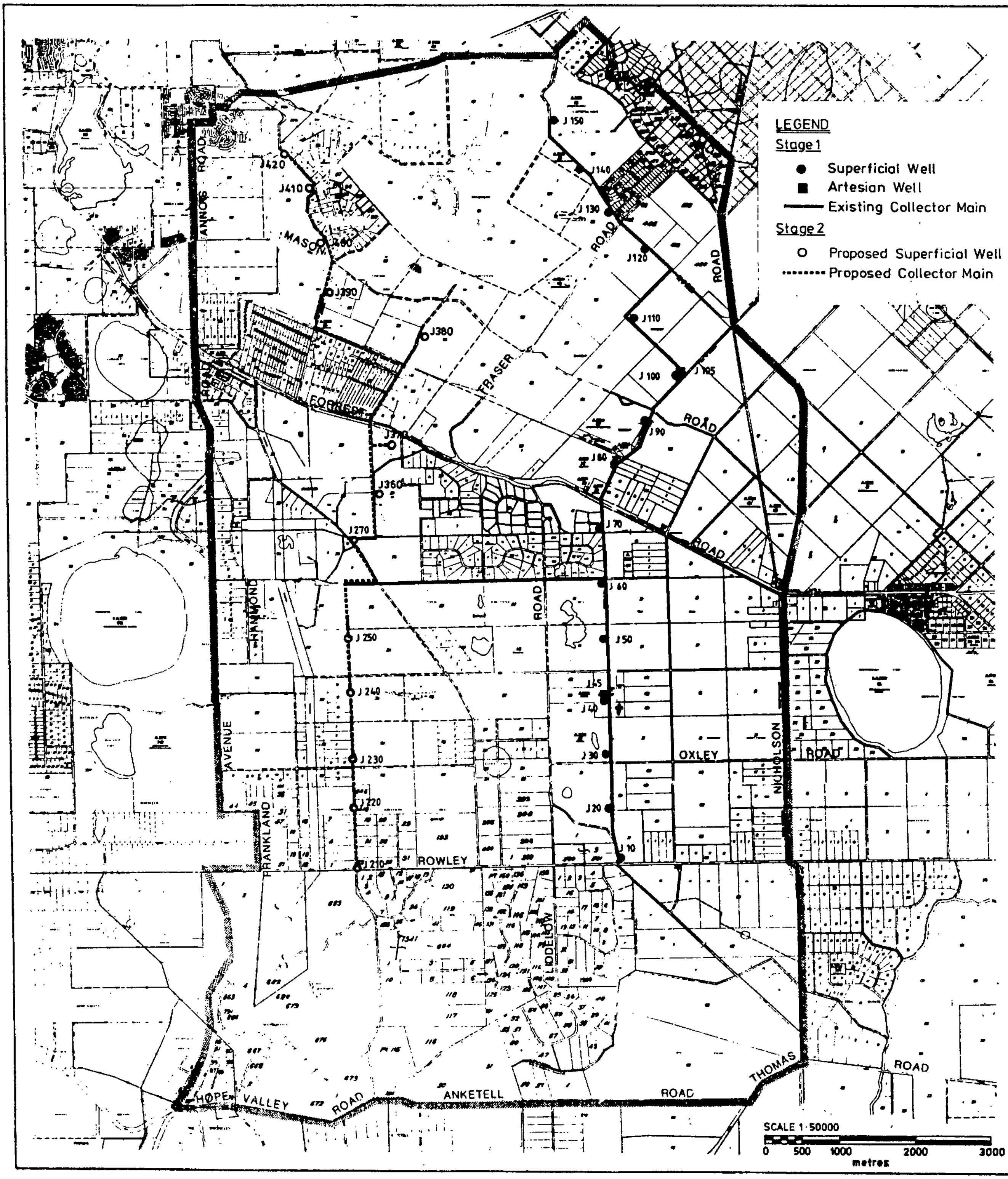

Figure 2: Location of existing and proposed public water supply wells.

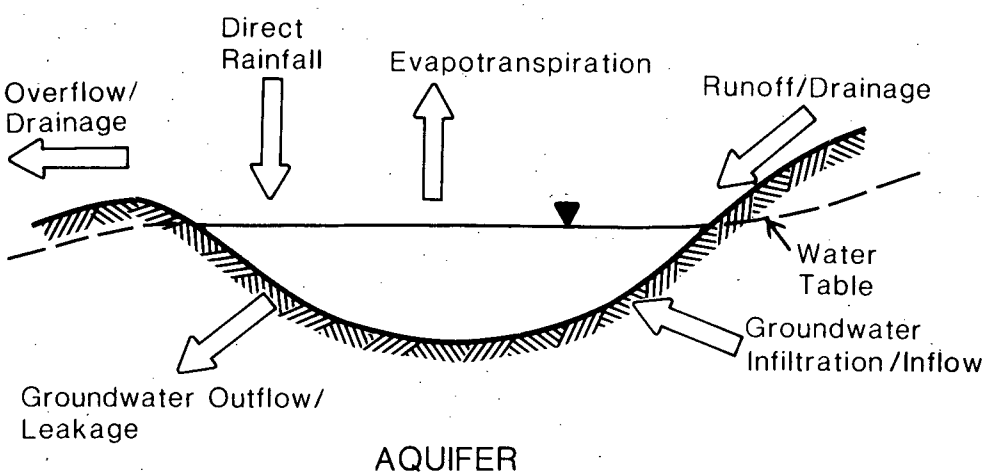

Figure 3: Schematic water balance for typical Swan Coastal Plain wetland.

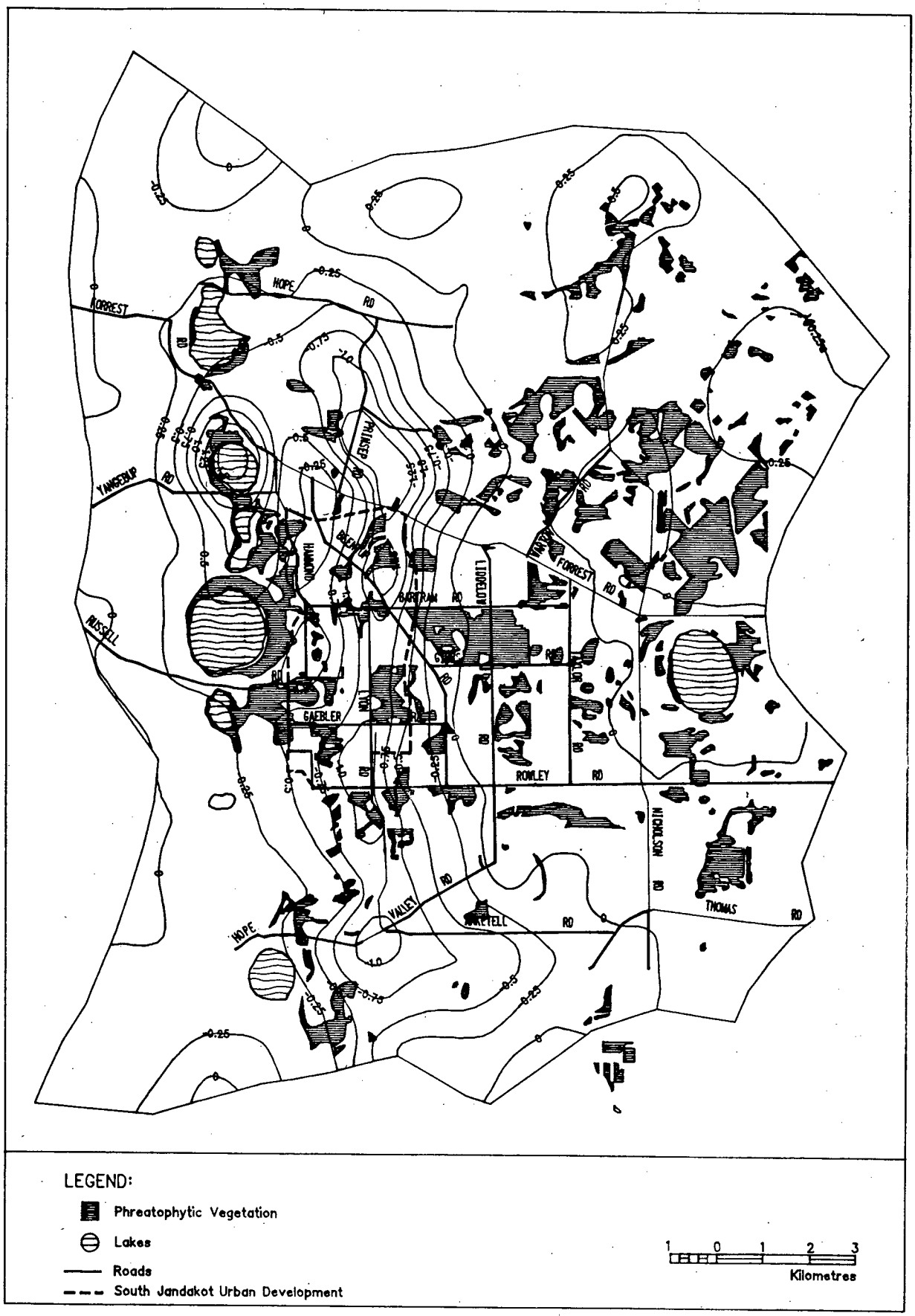

Figure 4: Simulated contours of water table level changes due to future land use with urbanisation and Stage 2 Jandakot GWS (Scenario 3). Also shown are the areas of phreatophytic vegetation (ie, vegetation in areas where the depth to water table is less than 5 metres).