# Groundwater resource allocation, East Gnangara

## Water and Rivers Commission

**Report and recommendations**
**of the Environmental Protection Authority**

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## Summary

This report is to provide the advice and recommendations of the Environmental Protection Authority (EPA) to the Minister for the Environment, about the establishment of environmental water provisions proposed for East Gnangara. The report is based on the environmental factors relevant to the proposal.

Water and Rivers Commission propose to allow groundwater abstraction for public water supply and private water uses from the eastern side of the Gnangara Mound, while allowing for provision of groundwater to the environment. Abstraction for public use will provide for urban development in the north-east corridor in addition to supplementing the Perth metropolitan water supply.

### Relevant Environmental Factors

Although a number of environmental factors were considered by the EPA in the assessment, it is the EPA's opinion that the following are the environmental factors relevant to the proposal, which require detailed evaluation in the report:

(a) Terrestrial vegetation - impacts on regionally significant and phreatophytic vegetation from groundwater drawdown; and

(b) Wetlands and seepages - impacts from groundwater drawdown.

### Conclusions

The EPA has considered the proposal by the Water and Rivers Commission for environmental water provisions on the eastern side of Gnangara Mound. The EPA has concluded that the proposal can be managed to meet the EPA's objectives, provided that the conditions in Section 4 and set out in detail in Appendix 3 are imposed.

The EPA considers that the key environmental factors associated with this proposal are the impacts of groundwater drawdown on phreatophytic vegetation and wetlands. The EPA considers the effects of groundwater drawdown can be managed to acceptable levels, particularly by ensuring the rate of drawdown is progressively implemented to minimise impacts.

### Recommendations

The EPA submits the following recommendations to the Minister for the Environment:

1. That the Minister considers the report on the relevant environmental factors of terrestrial vegetation, wetlands and seepages set out in Section 3.
2. That the Minister notes that the EPA has concluded that the proposal can be managed in an environmentally acceptable manner, provided there is satisfactory implementation by the proponent of the recommended conditions set out in Section 4.
3. That the Minister imposes the conditions recommended in Appendix 3 of this report.

# Contents

## 1. Introduction

This report provides the advice and recommendations of the Environmental Protection Authority (EPA) to the Minister for the Environment on the environmental factors relevant to the proposal by the Water and Rivers Commission (WRC) to establish and implement environmental water provisions (EWPs) at East Gnangara. Establishment of EWPs will allow the Water and Rivers Commission to allocate groundwater for abstraction from the eastern side of the Gnangara Mound.

The proposal for environmental water provisions was referred to the EPA in January 1995, and the level of assessment was set at Public Environmental Review.

The East Gnangara Environmental Water Provisions Plan, referred to here as the PER (WRC 1997), was made available for public review between 27 October 1997 and 22 December 1997. It can be viewed at the Department of Environmental Protection (DEP) library.

In compiling this report, the EPA has considered the environmental factors associated with the development, issues raised by the public, specialist advice from government agencies, the proponent's response to issues raised, the EPA's own research and, in some cases, research provided by other expert agencies.

The report sets out the environmental factors that the EPA considers are relevant to the proposal and the conditions and procedures which should be applied if it is implemented.

## 2. The Proposal

The scope and objectives of the East Gnangara Environmental Water Provisions Plan encompassed a number of factors, including:

- identification of ecosystem components with high environmental and social values,
- determination of environmental water requirements (EWRs) and EWPs for each ecosystem component,
- determination of quantity of water available for public and private groundwater abstraction,
- computer modelling of differing abstraction scenarios to model likely impact of groundwater abstraction,
- prediction of the changes in water levels induced by groundwater abstraction, to determine if conflicts are likely,
- proposed longterm management and monitoring of groundwater in the study area.

The PER document discussed how the groundwater, after provisions were made to the environment, was to be allocated between public and private users (PER, section 15). The WRC included this in the PER as it believed that private water allocation is of considerable interest to the community. As the EPA's interest is to ensure protection of the environment, the WRC has advised that EPA need not consider the allocation of groundwater between public and private users in this assessment (PER, p 1-2).

The concept of EWRs and EWPs as applied by the WRC has previously been accepted by the EPA when assessing the changes to environmental conditions for the Gnangara Mound groundwater resources (Bulletin 817, May 1996). The EWR is the water requirement of a particular component of the environment required to maintain its ecological values and functions in their current state. The EWP is that portion of the EWR that will be provided. In instances where the full EWR will not be met, some adverse change to that component of the environment

can be expected. The key issue for this assessment is whether the proposed EWPs meet the EPA's environmental objectives.

In the development of the PER, the WRC considered the environmental characteristics of the study area, and made an assessment of the ecological value of different components of the environment dependent on groundwater. The groundwater-dependent components of the environment in the study area include phreatophytic (groundwater-dependent) vegetation, wetlands and seepages. EWRs were established for each environmental component, based on the assessment of their ecological value. EWPs were assigned on the basis of the competing demands for the water resource relevant to that environmental component.

Groundwater-dependent components of the environment for which EWRs and EWPs were determined in the study area include terrestrial vegetation (Banksia woodlands), wetlands and seepages.

EWRs for vegetation were established for the majority of monitoring wells in Whiteman and Melaleuca Parks in the Gnangara Mound Section 46 Report (Water Authority of Western Australia 1995) and reported on in EPA Bulletin 817. EWRs for other monitoring wells in the East Gnangara study area were determined in a similar manner, ie subtracting 1.5m from the average minimum groundwater level at each monitoring well in the early 1970's (prior to the current drought period). Banksia species are believed to be able to tolerate a progressive water table drawdown of 1.5m, at a rate of 0.2m per year. Trees on sites with less than 6m to groundwater are most susceptible to drawdown (WAWA 1992).

Interim EWRs for wetlands have been determined as the basin water requirements of the wetland vegetation until the degree of perching, and consequent reliance on groundwater, has been established for each wetland. Interim EWRs were derived from analysis of historical data on natural water regime and vegetation present at each wetland, and were set as minimum, maximum and absolute minimum water levels for each wetland. It is proposed that water levels are not to fall below the set minimum water levels more than two years in six, and absolute minimums are not breached at all.

Two seepages of significant conservation and environmental value remain intact in the study area, the Edgecombe and Egerton seepages (Figure 1) (Jasinka and Knott 1994). There has been limited data collection on natural water regimes feeding springs or seepages on the east Gnangara Mound. Consequently EWRs proposed for the two seepages are interim, pending the collection of further data.

Details of proposed EWRs and EWPs for terrestrial vegetation, wetlands and seepages are provided in Table 1.

An EWP for the Edgecombe seepage has not been established as factors affecting the groundwater level at this site are beyond the control of WRC, but it is recommended that the groundwater table upstream of the Edgecombe seepage be maintained at 14.35m AHD to sustain the 2m seepage area. The EWP for the Egerton seepage has been set to equal the EWR, to maintain the permanent flow of water believed to feed the seepage.

Locations of monitoring wells in the study area for terrestrial vegetation with established EWRs and EWPs and wetlands and seepages with interim EWRs are provided in Figure 1.

Abstraction will allow the development the Lexia groundwater scheme by the Water Corporation, which will provide for urban development in the north-east corridor, in addition to supplementing the Perth metropolitan water supply and providing groundwater for private users. The Lexia groundwater scheme comprises 11 superficial wells centred in the Gnangara pine plantations of State Forest 65 (SF65), and one semi-confined (Mirrabooka sands) well east

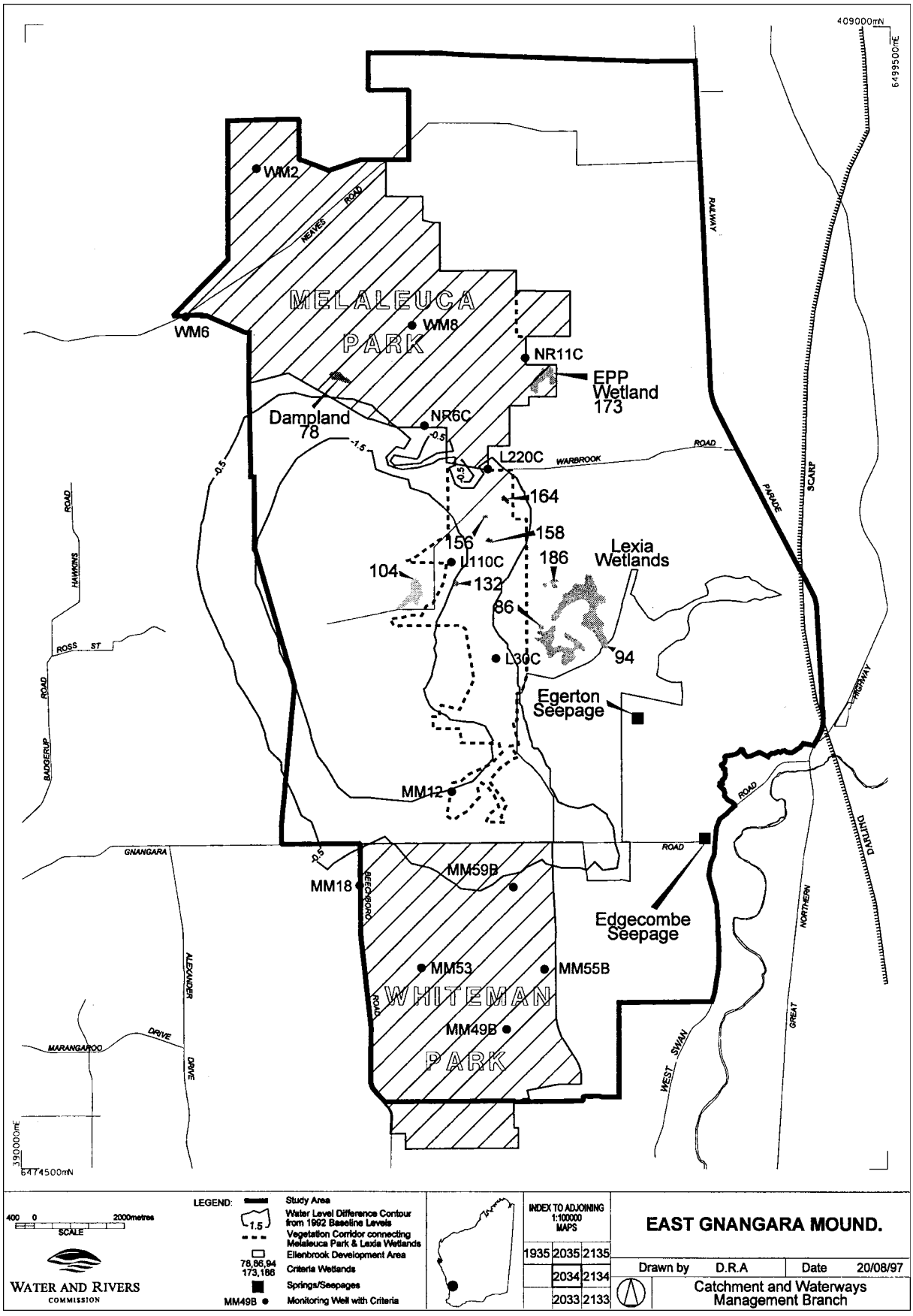


***Figure 1. Location of monitoring wells, wetlands and seepages in the East Gnangara study area (source: WRC 1998).***

**Table 1. Summary of proposed environmental criteria for terrestrial vegetation, wetlands and seepages in East Gnangara study area.**

| Location | Monitoring Well | EWR (min water level mAHD) | EWP (min water level mAHD) | EWP < EWR (m) |
|---|---|---|---|---|
| **Vegetation** | | | | |
| Melaleuca Park | WM6 | 58.8 | 58.3 | 0.5 |
| Melaleuca Park | WM8 | 65 | 64.8 | 0.2 |
| Melaleuca Park | NR6C | 58.5 | 58.5 | - |
| Melaleuca Park | WM2 | 67 | 66.5 | 0.5 |
| Melaleuca Park | NR11C | 55 | 55 | - |
| Whiteman Park | MM49B | 24.7 | 24.7 | - |
| Whiteman Park | MM53 | 33.3 | 33.3 | - |
| Whiteman Park | MM55B | 29.5 | 29.5 | - |
| Whiteman Park | MM18 | 38.6 | 38.6 | - |
| Whiteman Park | MM59B | 36.3 | 36.3 | - |
| Vegetation Corridor | MM12 | 43 | 42 | 1.0 |
| Vegetation Corridor | L30C | 47.5 | 47.2 | 0.3 |
| Vegetation Corridor | L110C | 57 | 55.7 | 1.3 |
| Vegetation Corridor | L220C | 52.5 | 52.2 | 0.3 |

| **Wetlands** | | **EWR** [a] **Minimum** | **Absolute minimum** |
|---|---|---|---|
| Melaleuca Park 78 | GNM13 | 5.5m below ground | 5.8m below ground |
| Melaleuca Park 173 | GNM14 | 0.1m above ground | 0.1m above ground |
| Lexia 186 | GNM15 | 0.8m below ground | 1.1m below ground |
| Lexia 86 | GNM16 | 1.0m below ground | 1.3m below ground |
| Lexia 94 | GNM17A | 1.5m below ground | 1.8m below ground |

| **Seepages** | | **EWR** | **EWP** |
|---|---|---|---|
| Edgecombe | B10 | 14.35 [b] | [b] |
| Egerton | B25 | 39.29 [c] | 39.29 [c] |

a: Interim EWRs and absolute minimum water levels have been determined for these wetlands. EWPs will be provided following investigation of stratigraphy and water regimes, and reported in the triennial review.

b: Recommendation for management only. The seepage is outside the zone of influence of the proposal; final water levels are expected to be affected by factors unrelated to groundwater abstraction for public water supply.

c: Access to land required before monitoring can be conducted.

of SF65 (Figure 2). A further two superficial wells for the East Mirrabooka Stage 3 scheme are proposed. Total yield will be 11 x $10^6$ kL/yr. The infrastructure for the Lexia wellfield has been previously assessed by the EPA, and is proposed to be operational by late 1999.

The model used by the WRC to allow prediction of water levels in the future incorporated a number of variables, including private groundwater abstraction, urbanisation, climatic variation, pine basal area and well layout. The declines predicted are the result of maximum utilisation of groundwater by each component of the model. The final water level attained on the Mound will be dependent on the interaction between any of the above variables and may not stabilise while drawdown rates are fluctuating. Climatic variability was the single most unpredictable variable in modelling future groundwater levels.

## 3. Relevant environmental factors

Section 44 of the *Environmental Protection Act 1986* requires the EPA to report to the Minister for the Environment on the environmental factors relevant to the proposal and on the conditions and procedures to which the proposal should be subject, if implemented. In addition, the EPA may make recommendations as it sees fit. It is the EPA's opinion the following are the environmental factors relevant to the proposal, which require detailed evaluation in this report:

(a) Terrestrial vegetation - impacts on regionally significant and phreatophytic vegetation from groundwater drawdown; and (Section 3.1)

(b) Wetlands and seepages - impacts from groundwater drawdown. (Section 3.2)

The above relevant factors were identified from the EPA's consideration and review of all environmental factors (preliminary factors) generated from the PER document and the submissions received, in conjunction with the proposal characteristics (including significance of the potential impacts), the adequacy of the proponent's response and commitments, the effectiveness of current management and alternative approval processes which are designed to ensure that the factors will be appropriately managed.

Table 2 summarises the environmental factors considered by the EPA from which the relevant factors were determined. On this basis, the EPA considers that the groundwater quantity and aboriginal heritage factors and other issues raised in the submissions do not require further evaluation by the EPA. These factors either have manageable impacts, are addressed by the proponent's commitments, or are covered by other environmental control processes.

Detail on the relevant environmental factors and their assessment is contained in Sections 3.1 to 3.2 below, and a summary is given in Table 3.

### 3.1 Terrestrial vegetation - impacts on regionally significant and phreatophytic vegetation from groundwater drawdown

#### Description

The study area contains extensive phreatophytic vegetation in Melaleuca and Whiteman Parks, the Ellenbrook bushland, and in the tract of native vegetation between Melaleuca Park and Ellenbrook bushland (referred to as the vegetation corridor) (Figure 3). These areas have all been identified by the DEP as regionally significant. Melaleuca Park consists wholly of the management priority area of the System 6 Reserve M9 and Whiteman Park comprises System 6 Reserve M13.

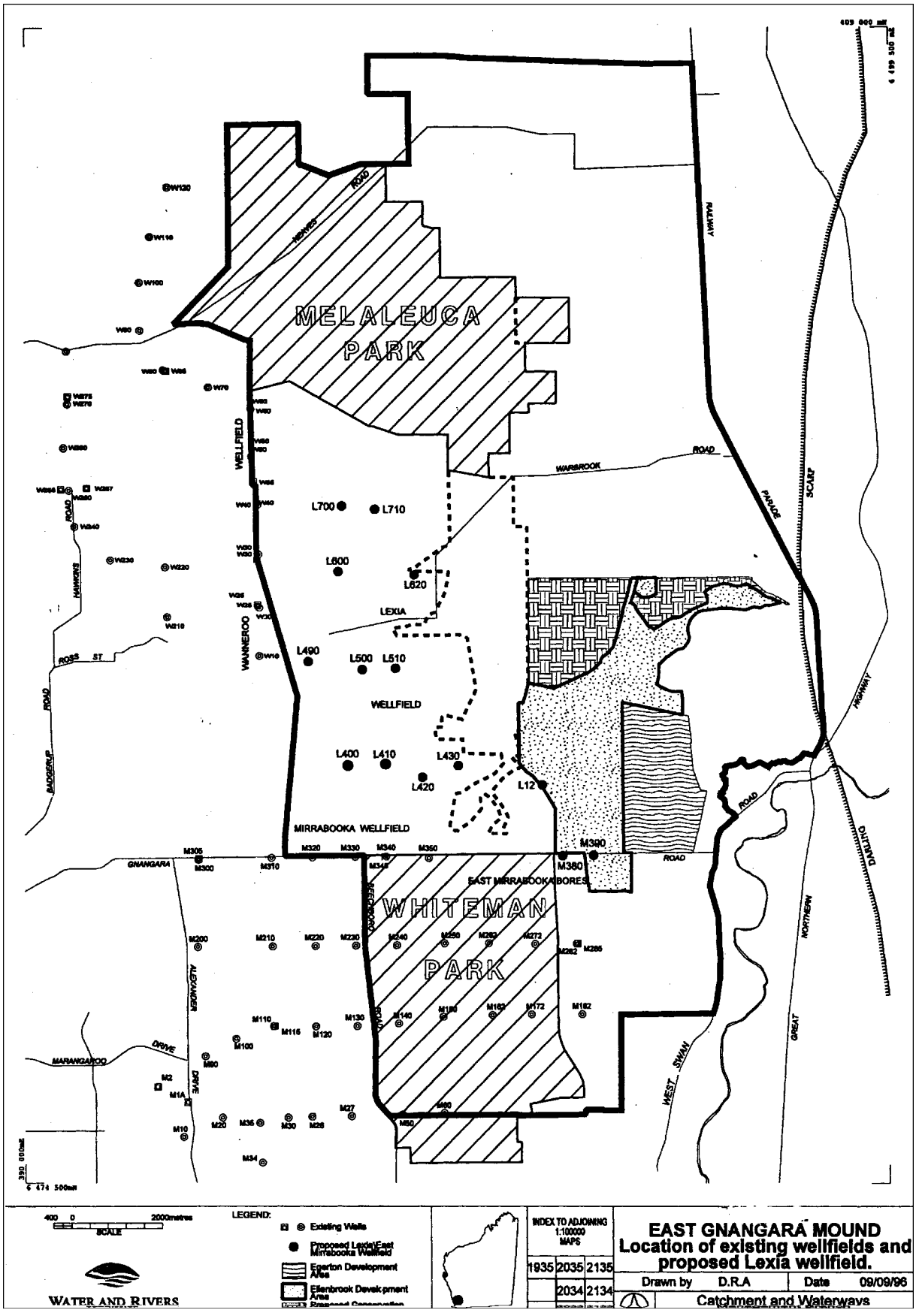


***Figure 2. Location of production wells for the proposed Lexia wellfield (Source: WRC 1997).***

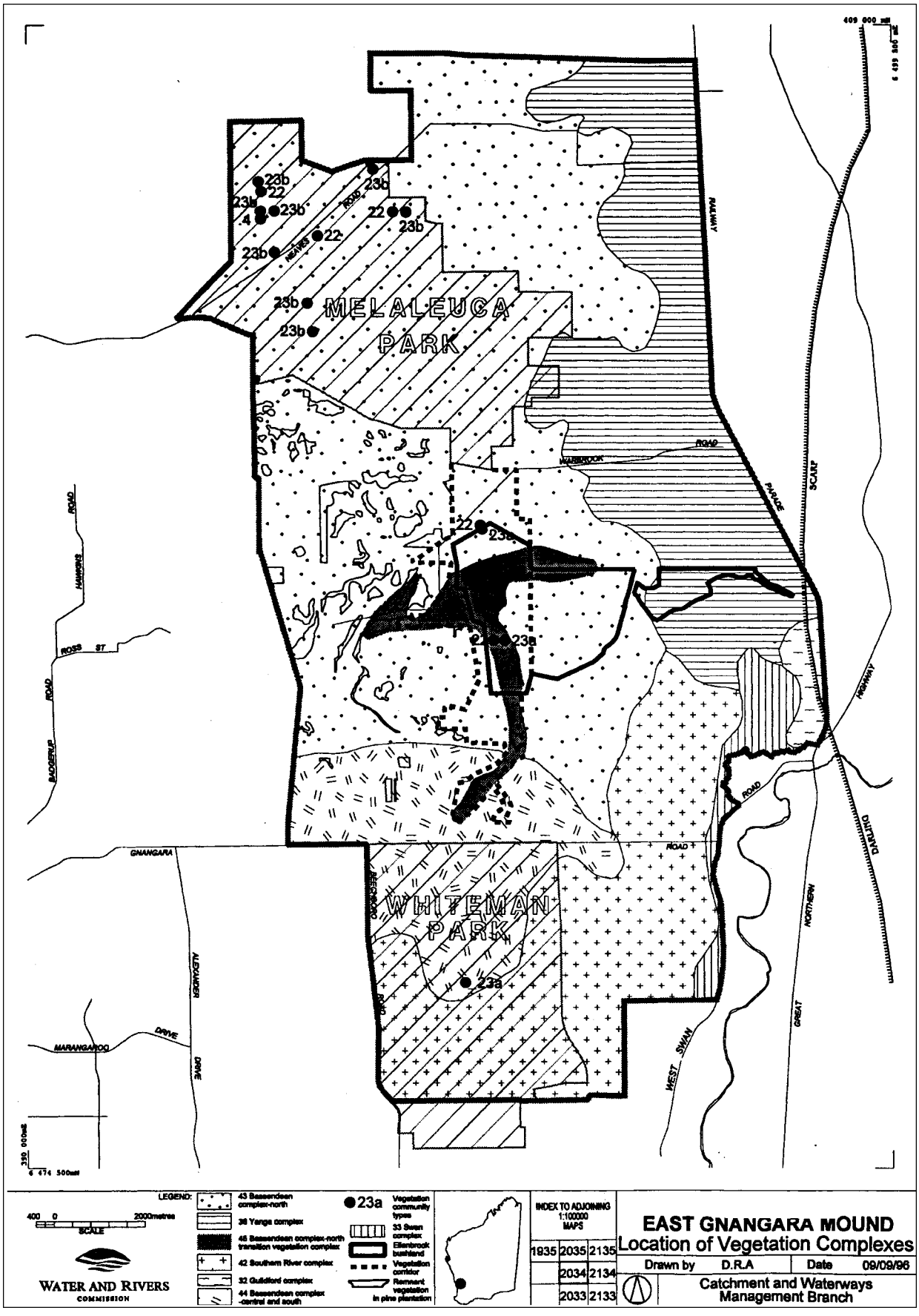


*Figure 3. Vegetation complexes in the East Gnangara study area (Source: WRC 1997).*

Melaleuca Park contains the Bassendean Complex-North and the Yanga Complex (Heddle *et al* 1980) plant communities. The Yanga Complex is confined to the Pinjarra Plain and comprises closed *Melaleuca* scrub, with low open forest of *Casuarina obesa* favoured by low-lying water-gaining areas. This complex is poorly reserved, and has been extensively cleared for agriculture in the past, with less than 10% of the estimated original coverage remaining. Melaleuca Park also contains the most important remaining example of the Bassendean Complex-North within State forest.

The floristic community types developed by Gibson *et al*. (1994) represented in Melaleuca Park include community types 4 (*Melaleuca priessiana* damplands), 21c (*Banksia attenuata* low lying woodland), 22 (*B. ilicifolia* woodland) and 23a and 23b (Central and Northern *B. attenuata* and *B. menziesii* woodland).

The Ellenbrook bushland is a continuation of the vegetation contained in Melaleuca Park, with the Bassendean Complex-North, limited occurrences of Bassendean Complex-North Transition and the Yanga Complex represented. Communities 4, 5 (mixed shrub damplands), 18 (shrublands on calcareous silts), 21a, 21c, 22, and 23b are represented, while types 5 and 18 are not represented in Melaleuca Park. The Ellenbrook bushland is a particularly species rich remnant of the vegetation of the Swan Coastal Plain, and contains a number of rare or priority flora taxa.

Whiteman Park contains the Bassendean Complex-Central and South, and the only reserved occurrence of the Southern River complex. Additionally, community types 4, 21c and 22 are represented in Whiteman Park.

The vegetation corridor contains the Bassendean Complex-North, Bassendean Complex-North Transition and floristic community types 22 and 23a. The Bassendean Complex-North Transition comprises low open forest or woodland of *Banksia* spp and *Eucalyptus todtiana.* It is geographically restricted, being originally limited to six small patches between Gnangara Road and Gingin and one larger patch which straddles the Moore River. Parts of some of the areas have been cleared. In the study area, this complex is restricted mainly to the vegetation corridor, with small occurrences in the Ellenbrook bushland.

Vegetation complexes and floristic community types, including their reservation and conservation status are summarised in Tables 4 and 5.

Changes in community structure over the Gnangara Mound due to groundwater abstraction may be confounded by climatic events. A trend of decreasing soil moisture in response to below average rainfall over the past 20 years has been observed at sites remote from groundwater abstraction, with consequent changes in the vegetation from phreatophytic to more xeric communities.

### Assessment

The area considered for assessment of this environmental factor is the East Gnangara Groundwater Mound study area (Figure 1).

The EPA's environmental objective in regard to this factor is to maintain abundance, species diversity, geographic distribution and productivity of vegetation communities.

## Table 2. Identification of relevant environmental factors

| Factors | Proposal Characteristics | Public and Government Agency Comments | Identification of Relevant Factors |
|---|---|---|---|
| **Biophysical** | | | |
| Terrestrial vegetation | EWPs less than EWRs are proposed in the vegetation corridor. Groundwater drawdown in the vegetation corridor may be up to 2m (0.3-1.3m below EWRs), with groundwater levels predicted to fall below EWRs in up to one in three years. This will result in a gradual shift to a more drought tolerant community structure. Some loss of mature banksia trees is anticipated, exacerbating continued dry climatic influence. Production wells near the vegetation corridor will be phased in.<br>EWPs for Whiteman Park and Melaleuca Park will remain the same as those developed for the Gnangara S46 (EPA Bulletin 817). Minimal impact in these areas is expected as a result of groundwater allocations associated with this proposal. Groundwater levels are predicted to fall below EWRs due to climatic influences in up to 17% of years in Melaleuca Park. | **Government**:<br>CALM: Proposed drawdown under the vegetation corridor will result in changes to the vegetation.<br>Drawdown is likely to have an impact on CALM's ability to revegetate the areas after pine removal.<br>**Public:**<br>Continuing change toward drought tolerant vegetation communities or loss of bush is unacceptable. | **This factor warrants further evaluation.** |
| Wetlands and seepages | **Wetlands**: Interim EWRs have been determined for five wetlands, until degree of perching established. EWPs will be proposed for these wetlands in the next triennial review of groundwater monitoring, following the investigations of the degree of perching.<br>Anticipated drawdowns in the vicinity of wetlands with EWRs<br>• 0.25m in dampland 78<br>• <0.25m in Lexia wetlands 86 and 186<br>• EPP wetlands 173 and Lexia 94 will not be affected<br>The WRC does not expect that these drawdowns will significantly affect the environmental values of these wetlands.<br>Four conservation category wetlands will experience groundwater drawdown of between 0.7 and 1.5m. The WRC has made a commitment to monitor the impacts on these wetlands and implement mitigation measures and/or replace wetland values if these are lost.<br>A *Melaleuca rhaphiophylla* wetland in the centre of the pine plantation is restricted in its geomorphological association. Drawdown in the vicinity of this wetland is expected to be 3m from the current depth of 1.8m. The WRC has made a commitment to monitor this wetland and implement mitigation measures and/or replace or compensate for the loss wetland values if these are lost..<br>**Seepages**: Two groundwater seepages in the eastern zone of the East Gnangara Study area are on the edge of the zone of influence. The EWP for the Egerton seepage has been set to equal the EWR, to maintain the permanent flow of water upstream believed to feed the spring.<br>Proposed urban development at Egerton, upstream of the Edgecombe seepage is considered likely to have a greater effect on this seepage than groundwater abstraction from the Lexia scheme. With urbanisation, irrigation of the Egerton property will cease, resulting in a predicted 0.2m decline in the local groundwater. As a consequence, an EWP for the Edgecombe seepage has not been established, but it is recommended that the groundwater table upstream of the seepage be maintained at 14.35m AHD to sustain the 2m head of seepage area at Edgecombe. | **Government:**<br>CALM: Commitment of resources may be better directed toward other nature conservation works, instead of wetland mitigation of the *Melaleuca rhaphiophylla* wetland in the pine plantation.<br>**Public**:<br>Current wetland water levels are low, and are a reflection of the low rainfall of the previous 20 years. The effect of allowing pumping to maintain water levels at a predetermined minimum may affect vegetation structure in the long term.<br>Monitoring should be more intense in the first five years. 135 wetlands exist in the study area.<br>Long term integrity of Egerton Seepage has not been guaranteed. Increased abstraction, in addition to inadequate buffers from the proposed urban development close to the seepage will increase pressure on this important wetland.<br>Flow leaving the Mound will be reduced by increased abstraction. This will affect stream systems reliant on groundwater flow. Bennet Brook in particular will be affected, as the headwaters for this stream originate in Whiteman Park and will not receive drainage waters. Bennett Brook has suffered from groundwater abstraction in the past. | **This factor warrants further evaluation.** |

| | | | |
|---|---|---|---|
| Groundwater quantity | Rural properties in the North-east of the scheme with a high groundwater table may experience a reduction in summer pasture growth. Water levels in small private dams may also be affected.<br><br>Artificial lakes in Ellenbrook and proposed Egerton estate may not receive the water allocation expected by the developers.<br><br>Private bores: Water availability to rural properties is not expected to be affected, although watertable may drop 0.25-0.5m in the north eastern area.<br><br>**Pine management**: Pines are to be managed to a basal area of 11 $m^2$ ha, representative of the original vegetation. The Gnangara Conservation Park proposed by CALM for SF65 will involve the progressive clearing of pines over the next 20 years, resulting in significant rises in groundwater levels. | **Government**:<br><br>CALM request that a portion of the groundwater made available after harvesting of pines is allocated to the rehabilitation of the Gnangara Park.<br><br>**Public**:<br><br>None received | **Management of pines by CALM has been the subject of previous EPA consideration and there is no need to further expand in this assessment.**<br><br>**This factor does not warrant further evaluation. The EPA has not considered the allocation of groundwater between users in this assessment.** |
| **Social Surroundings** | | | |
| Aboriginal heritage | Large wetlands within the East Gnangara study area important to Aborigines include Yakine Swamp, Mussel Brook and Ellen and Bennett Brooks. Many smaller wetlands were also important as sources of food and water. | **Government:** The Department of Aboriginal Affairs recommends involving the local Aboriginal community directly when developing public involvement and awareness programs.<br><br>**Public:** The Swan Valley Nyungah community requests WRC to liaise directly with them regarding the proposal. | **Extensive surveys and consultation was undertaken in development of the Plan.**<br><br>**The WRC have committed to ongoing liaison with the Swan Valley Nyungah community .** |

**Table 3. Summary of assessment of relevant environmental factors.**

| Factor | Relevant Area | EPA Objective | Assessment | EPA Advice |
|---|---|---|---|---|
| Terrestrial vegetation | East Gnangara study area | Maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities. | EWPs are proposed in the vegetation corridor which are below EWRs. Groundwater levels are predicted to fall below EWRs in the vegetation corridor in up to one in three years. This is expected to result in a gradual shift to a more drought tolerant community structure. Some loss of mature banksia trees is anticipated, exacerbating continued dry climatic influences.<br><br>EWPs are proposed to be equal to EWRs in Whiteman Park and much of Melaleuca Park.<br><br>Climatic influences are expected to have a greater effect than groundwater abstraction in Melaleuca Park, and EWRs are not expected to be met even with no further groundwater abstraction in up to 17% of years in parts of the Park. Wells will need to be turned off in up to 13% of years in Whiteman Park to ensure EWPs are met. | Having particular regard to:<br>• the proponent's commitment for production wells near the vegetation corridor to be phased in, to allow time for tree roots to follow the declining water table;<br>• the proponent's commitment to develop an MOU between CALM and WRC on pine harvesting;<br>• the sand mining proposed for the vegetation corridor for the next 50 years;<br>• the continuation and establishment of vegetation monitoring in Melaleuca Park, Whiteman Park, the vegetation corridor and the Ellenbrook bushland;<br><br>it is the EPA's opinion that the proposal can be managed to meet its objective for this factor, provided the proponent's commitments are made legally enforceable. |
| Wetlands and seepages | East Gnangara study area | Maintain the integrity, functions and environmental values of wetlands. | Four conservation category wetlands will be subject to a decline in groundwater levels of greater than 0.7m. Wetland 132 (vegetation corridor) will be the most severely affected, with groundwater levels in the vicinity expected to decline by 1.5. This wetland has an intact *M. preissiana, B. littoralis* and *B. ilicifolia* overstorey. Mature trees are expected to be lost as a result of groundwater drawdown.<br><br>Drawdown in the vicinity of a geomorphologically restricted *M. rhaphiophylla* wetland in the pine plantation is expected to be 3m from the current depth of 1.8m.<br><br>Maintenance of the permanent flow of water upstream of the Egerton seepage should be sufficient to ensure survival of the spring.<br><br>Proposed urban development at Egerton, upstream of the Edgecombe seepage is considered likely to have a greater effect on this seepage than groundwater abstraction from the Lexia scheme. WRC recommend that the groundwater table upstream of the seepage be maintained at 14.35m to sustain the 2m of seepage at Edgecombe. | Having particular regard to:<br>• the monitoring proposed for five wetlands within the study area;<br>• the containment of wetland 132 within the sand mining envelope in the vegetation corridor, and the proponent's commitment to develop a wetland mitigation strategy to minimise or manage impacts, or compensate for the loss of this wetland;<br>• the proponent's commitment to develop a wetland mitigation strategy to minimise or manage impacts, or compensate for the loss of wetlands 156, 158 and 164;<br>• the proponent's commitment to develop a wetland mitigation strategy to minimise or manage impacts, or compensate for the loss of the *Melaleuca rhaphiophylla* wetland (104) in the pine plantation;<br>• the degraded nature of the EPP wetland affected by the proposal; and<br>• the monitoring of aquatic invertebrates and vegetation proposed for selected wetlands,<br><br>it is the EPA's opinion that the proposal can be managed to meet its objective for this factor provided the proponent's commitments are made legally enforceable. |

**Table 4. Reservation and conservation status of vegetation complexes within the study area potentially impacted by groundwater abstraction.**

| Complex | Represented in | Reserv'n Status | Conserv'n status | Extant |
|---|---|---|---|---|
| Bassendean - North | Melaleuca Park, Ellenbrook bushland, vegetation corridor | Extremely good | Extremely good | 50% [1] 63% [3] |
| Bassendean - North Transition | Vegetation corridor, Ellenbrook bushland | Extremely good | Extremely good | 60% 86% [3] |
| Yanga | Melaleuca Park, Ellenbrook bushland | Poorly reserved | Extremely poor | <10% [2] 9% [3] |
| Bassendean - Central and South | Whiteman Park | Poorly reserved | Extremely poor | 15% [1] 14.5% [3] |
| Southern River | Whiteman Park | Poorly reserved | Extremely poor | 8.6% [3] <7% [4] |

1. Trudgeon (1996)
2. Feilman Planning Consultants (1992)
3. Burbridge and Rolfe (1989)
4. Trudgeon and Keighery (1995).

**Table 5. Reservation and conservation status of floristic community types (after Gibson *et al*. 1994 and DEP 1996) within the study area potentially impacted by groundwater abstraction.**

| Comm. no. | Description | Represented in | Reserv'n status[1] | Conserv'n status |
|---|---|---|---|---|
| 4 | *Melaleuca priessiana* damplands | Melaleuca Park, Ellenbrook bushland, Whiteman Park | Well reserved | Low risk |
| 5 | Mixed shrub damplands | Ellenbrook bushland | Well reserved | Low risk |
| 18 | Shrublands on calcareous silts | Ellenbrook bushland | Poorly reserved | Vulnerable |
| 21a | Central *Banksia attenuata* - *E. marginata* woodlands | Ellenbrook bushland | Well reserved | Low risk |
| 21c | Low-lying *Banksia attenuata* woodlands or shrublands | Melaleuca Park, Whiteman Park | Well reserved | Susceptible |
| 22 | *Banksia ilicifolia* woodlands | Melaleuca Park, Ellenbrook bushland, Whiteman Park, vegetation corridor | Poorly reserved | Susceptible |
| 23a | Central *Banksia attenuata*- *B. menziesii* woodland | Melaleuca Park, vegetation corridor | Well reserved | Low risk |
| 23b | Northern *B. attenuata*- *B. menziesii* woodland | Melaleuca Park, Ellenbrook bushland | Unreserved | Susceptible |

[1]Well reserved = found in 2 or more National Parks or Nature Reserves
Poorly reserved = found in 1 National Park or Nature Reserve
Unreserved = not found in either a National Park or Nature Reserve.

Using the preferred well layout and abstraction volumes, and with full urbanisation in Ellenbrook and Egerton, total utilisation of private groundwater allocations, and a pine basal area of 11 $m^2$/ha, the following declines on groundwater levels are predicted;

- 0.25m in the south of Melaleuca Park,
- <0.5m on the western boundary of Ellenbrook bushland,
- 0.25 - 0.5m in the northern third of Whiteman Park, and
- 0.5 - 2.0m in the vegetation corridor.

Vegetation complexes and communities most likely to be affected by the proposal are those in the vegetation corridor. The WRC has proposed EWPs in this area which are up to 1.3m below EWRs. Groundwater levels are predicted to fall below the EWRs in the vegetation corridor in up to one in three years. This is expected to result in a gradual shift to a more drought tolerant community structure, with some loss of mature banksia trees, exacerbating continued dry climatic influences. The proponent is committed to the phasing in of production wells near the vegetation corridor, to allow time for tree roots to follow the declining water table.

The three most common Banksia species in the study area are *Banksia menziesii, B. ilicifolia* and *B. attenuata.* Of these, *B. ilicifolia* woodlands (community 22) favour low-lying areas and are highly dependent on near surface groundwater tables. This community type is represented in the vegetation corridor, and will be susceptible to groundwater drawdown. The EWPs have been set to equal the EWRs in Whiteman Park and much of Melaleuca Park. Climatic influences are expected to have a greater effect than groundwater abstraction in Melaleuca Park, and EWRs are not expected to be met even with no further groundwater abstraction in up to 17% of years in parts of Melaleuca Park. The WRC has predicted that wells will need to be turned off in up to 13% of years in Whiteman Park to meet EWPs proposed in this area.

Concerns were expressed in the public submissions on the cumulative effect of groundwater drawdown on vegetation structure and composition in the study area. The EPA notes however, that only the vegetation corridor is likely to be significantly affected by groundwater allocation associated with the proposal. Some loss may be expected but, in general, species diversity in the vegetation corridor is not expected to change. In addition, natural changes in vegetation structure over much of the Gnangara Mound at locations remote from groundwater abstraction have been observed as a result of climatic influences.

Progressive pine removal from plantations in proximity to the vegetation corridor is expected to compensate to some extent for groundwater drawdown in this region. A commitment by the proponent to develop a Memorandum of Understanding with CALM on pine management is expected to address issues associated with the removal of the pine plantation over the next 20 years.

Sand mining is proposed for the lower half of the vegetation corridor, with granted Mining Leases valid for the next 50 years. The sand mines have previously been assessed by the EPA in 1988 and reported in Bulletin 318. Removal of extensive tracts of native vegetation in the central and southern portion of the corridor is likely to occur to allow the mining of the sand resource. Ministerial conditions in relation to rehabilitation and end land use acceptable to the EPA have been imposed.

Having particular regard to:

(a) the proponent's commitment to manage groundwater abstraction to meet EWRs, and monitor vegetation impacts with a view to revising EWRs if appropriate;

(b) the proponent's commitment for production wells near the vegetation corridor to be phased in, to allow time for tree roots to follow the declining water table;

(c) the proponent's commitment to develop an Memorandum of Understanding between the Department of Conservation and Land Management (CALM) and WRC on pine harvesting;

(d) the proponent's commitment to continue existing, and establish further vegetation monitoring in Melaleuca Park, Whiteman Park, the vegetation corridor and the Ellenbrook bushland; and

(e) the proponent's commitment to map vegetation on the Gnangara Mound to enable identification of environmental constraints to further groundwater abstraction,

it is the EPA's opinion that the proposal can be managed to meet its objective for this factor, provided the proponent's commitments are made legally binding.

## 3.2 Wetlands and seepages

### Description

*Wetlands.* A total of 135 wetlands are present in the study area, the majority of which will be unaffected by the proposal. A decline in groundwater levels is likely to reduce the size of the affected wetlands and shorten the period over which a wetland contains water each year.

Five wetlands considered representative of wetlands with high conservation value in the study area were identified for investigation and determination of EWRs. These include three from the Lexia suite (86, 94 and 186), one from a group of three EPP listed wetlands in the south-east of Melaleuca Park (173), and a dampland in the south-west of Melaleuca Park (78) (Figure 1).

*Seepages.* The Egerton and Edgecombe seepages are downstream of the proposed Lexia wellfield on the eastern edge of the zone of influence.

Proposed urban development at Egerton, upstream of the Edgecombe seepage is considered likely to have a greater effect on this seepage than groundwater abstraction from the Lexia wellfield. With urbanisation, irrigation of the Egerton property with water sourced from the confined aquifer will cease, resulting in a predicted 0.2m decline in the local groundwater levels.

The Egerton seepage will also be affected by the urban development proposed for Egerton, with the seepage being incorporated into public open space within the estate. This seepage contains pristine vegetation, and supports a club moss and liverworts considered to be extreme geographical outliers. Additionally, a previously unrecorded amphipod was collected from Egerton seepage in a survey in 1994. This amphipod was found to be an undescribed genus (Jasinska and Knott 1994). Invertebrates found in the Edgecombe and Egerton seepages are likely to be dependent on permanent water, with little resistance to drying.

## Assessment

The relevant area for this factor is the East Gnangara Study Area (Figure 1).

The EPA's objective in relation to this relevant environmental factor is to maintain the integrity, functions and environmental values of wetlands.

Anticipated drawdowns for the five wetlands where interim EWRs have been determined are:

- 0.25m in dampland 78
- <0.25 in Lexia wetlands 86 and 186
- EPP wetland 173 and Lexia wetland 94 will be unaffected

The WRC considers that drawdowns of less than 0.25m will not result in any loss of environmental values for these wetlands. The WRC will carry out further investigations of these wetlands to determine the degree of perching of groundwater and propose EWPs for them to protect their environmental values.

The wetlands in the study area that will be subject to greater groundwater drawdown will be affected to varying degrees (Table 6). Four conservation category wetlands will be subject to a decline in groundwater levels greater than 0.7m, in addition to one (169) protected by the Environmental Protection (Swan Coastal Plain Lakes) Policy 1992 (EPP). A number of smaller wetlands contained in the pine plantations will also suffer from a groundwater decline, however these have previously been degraded and impacted by drawdown from the pines.

**Table 6. Predicted drawdown and management of impacts of wetlands affected by groundwater drawdown.**

| Wetland | Tenure | Mgt categ. | Predicted drawdown (m) | Management proposed |
|---|---|---|---|---|
| 132 | State forest, vegetation corridor | C | 1.5 | Monitoring and mitigation or replacement if significant loss of values. Wetland is within sand mining envelope. |
| 156 | State forest, vegetation corridor | C | 1.0 | Monitoring and mitigation or replacement if significant loss of values. |
| 158 | State forest, vegetation corridor | C | 1.0 | Monitoring and mitigation or replacement if significant loss of values. |
| 164 | State forest, vegetation corridor | C | 0.7 | Monitoring and mitigation or replacement if significant loss of values. |
| 104 | State forest, pine plantation | RE | 3.0 | Monitoring and mitigation or replacement if significant loss of values. |
| 125 | State forest, Melaleuca Park | RE | 0.5 | No management proposed as impacts are likely to be negligible. |
| 159 | State forest, vegetation corridor | RE | 0.5 | No management proposed as impacts are likely to be negligible. |
| 169 (EPP) | Private property | MU | 0.5 | No management proposed as impacts are likely to be negligible. |
| 68 | State forest, vegetation corridor | MU | 2.0 | Impacts are likely to be negligible as few natural attributes remain. |

The four conservation category wetlands will be affected as follows:

- Wetland 132 (vegetation corridor) will be the most severely affected, with groundwater levels in the vicinity expected to decline by 1.5m. This wetland has an intact *Melaleuca preissiana, B. littoralis* and *B. ilicifolia* overstorey. Some tree and shrub species are expected to be lost, however replacement is expected to occur from recruitment. The effect of groundwater drawdown on water levels and vegetation health will be monitored as part of the monitoring program. This wetland is contained within the sand mining envelope in the vegetation corridor.

- Wetlands 156, 158 and 164 are to the north of the sand mining envelope, in the vegetation corridor. These wetlands will be subject to a predicted groundwater drawdown of between 0.7m and 1.0m. This is considered by WRC to be the maximum drawdown that these wetlands will be able to sustain, and it is expected that some mature trees will be lost. WRC recommend that the rate of groundwater drawdown not be greater than 0.2m per year.

In addition:

- A *M. rhaphiophylla* wetland (104) in the centre of the pine plantation which has a management category of Resource Enhancement is restricted in its geomorphological association. Drawdown in the vicinity of this wetland is expected to be 3m. Artificial maintenance will be considered once the degree of perching has been established, with replacement of the wetland in the event of significant loss of ecological values of the wetland.

- The EPP wetland 169 on private property has a predicted drawdown of 0.5m. The wetland has been heavily grazed and few natural attributes remain. Therefore it is not expected that groundwater allocations associated with this proposal will significantly affect the environmental values of this wetland.

Requirements of the life cycles of aquatic invertebrates have been included in the establishment of EWRs for wetlands. However the WRC admit that limited information is available on invertebrate species in half the selected wetlands. EWRs have been established to protect wetland vegetation, on the expectation that protection of the vegetation water requirements will in turn afford protection of the other values of the wetland. Results of spring 1996 and 1997 invertebrate sampling in the Lexia wetlands will be incorporated into the EWRs for these wetlands when available, with adjustments made if necessary.

The EPA considers that wetlands and seepages chosen for the determination of EWRs are representative of pristine systems remaining in the study area. The wetland monitoring proposed for wetlands is adequate to effectively monitor the health of the wetlands on an on-going basis, and ensure the early detection of any adverse effects of groundwater drawdown. The inclusion of wetland 132 (with a predicted drawdown of 1.5m) in the monitoring program will provide the proponent with information on species most susceptible to drawdown (indicator species), which can be used for early detection of disturbance in protected wetlands.

A decline of 1.5 m in the vicinity of wetland 132 will have a significant effect on the water cycle of this wetland. A change to a drier community structure is anticipated. Wetland 132 will also be indirectly affected by sand mining in the future, as the hydrology of the area will be changed after the excavation of the sand.

One EPP wetland will be impacted by the proposal, however a factor mitigating the impacts of groundwater drawdown on the wetland is its degraded nature. Summer pasture growth adjacent to the wetland will be limited. No public submissions regarding the effect of the proposal on water levels in private wetlands or dams were received.

The EPA notes the commitment by the proponent to develop a wetland mitigation strategy to minimise impacts in the remaining conservation category wetlands to be affected by the proposal, and to artificially maintain or compensate for the loss of the *M. rhaphiophylla* wetland in the pine plantation. This strategy is to be developed in consultation with CALM, the DEP and the Water Corporation. The Water Corporation will be responsible for implementing the strategy as part of the license conditions imposed by the WRC.

Having particular regard to:

(a) the proponent's commitment to manage groundwater abstraction to meet EWRs, and monitor wetland impacts with a view to revising EWRs if appropriate;

(b) the monitoring proposed for five wetlands within the study area where interim EWRs have been determined;

(c) the containment of the conservation category wetland 132 within the sand mining envelope in the vegetation corridor, and the proponent's commitment to develop a wetland mitigation strategy to minimise or manage impacts, or compensate for the loss of this wetland;

(d) the proponent's commitment to develop a wetland mitigation strategy to minimise or manage impacts, or compensate for the loss of conservation category wetlands 156, 158 and 164;

(e) the proponent's commitment to develop a wetland mitigation strategy to minimise or manage impacts, or compensate for the loss of the *Melaleuca rhaphiophylla* wetland (104) in the pine plantation;

(f) the degraded nature of the EPP wetland affected by the proposal; and

(g) the monitoring of aquatic invertebrates and vegetation proposed for selected wetlands,

it is the EPA's opinion that the proposal can be managed to meet its objective for this factor provided that the proponents commitments are made legally enforceable.

## 4. Conditions

Section 44 of the *Environmental Protection Act 1986* requires the EPA to report to the Minister for the Environment on the environmental factors relevant to the proposal and on the conditions and procedures to which the proposal should be subject, if implemented. In addition, the EPA may make recommendations as it sees fit.

In developing recommended conditions for each project, the EPA's preferred course of action is to have the proponent provide an array of commitments to ameliorate the impacts of the proposal on the environment. The commitments are considered by the EPA as part of its assessment of the proposal, and following discussion with the proponent the EPA may seek additional commitments.

The EPA recognises that not all of the commitments are written in a form which makes them readily enforceable, but they do provide a clear statement of the action to be taken as

part of the proponent's responsibility for and commitment to continuous improvement in environmental performance. The commitments then form part of the conditions to which the proposal should be subject if it is to be implemented.

The EPA may of course, also recommend conditions additional to that relating to the proponent's commitments.

Having considered the proponent's commitments and the information provided in this report, the EPA has developed a set of conditions which the EPA recommends be imposed if the proposal by WRC to allocate groundwater from the east Gnangara Mound, is approved for implementation. These conditions are presented in Appendix 3. Matters addressed in the conditions include:

- the proponent shall fulfil the commitments in the Consolidated Commitments statement set out as an attachment to the recommended conditions in Appendix 3.

## 5. Conclusions

The EPA has considered the proposal by the Water and Rivers Commission for environmental water provisions on the eastern side of Gnangara Mound. The EPA has concluded that the proposal can be managed to meet the EPA's objectives, provided that the conditions in Section 4 and set out in detail in Appendix 3 are imposed.

The EPA considers that the key environmental factors associated with this proposal are the impacts of groundwater drawdown on phreatophytic vegetation and wetlands. The EPA considers the effects of groundwater drawdown can be managed to acceptable levels, particularly by ensuring the rate of drawdown is progressively implemented to minimise impacts.

## 6. Recommendations

Section 44 of the *Environmental Protection Act 1986* requires the EPA to report to the Minister for the Environment on the conditions and procedures to which the proposal should be implemented. In addition, the EPA may make recommendations as it sees fit.

The EPA submits the following recommendations to the Minister for the Environment:

1. That the Minister considers the report on terrestrial vegetation, wetlands and seepages set out in Section 3.
2. That the Minister notes that the EPA has concluded that the proposal can be managed in an environmentally acceptable manner, provided there is satisfactory implementation by the proponent of the recommended conditions set out in Section 4.
3. That the Minister imposes the conditions recommended in Appendix 3 of this report.

# Appendix 1

## List of submitters

**State and local government agencies:**

Aboriginal Affairs Department
Department of Minerals and Energy
Shire of Swan

**Organisations:**

Aboriginal Corporation
Amber Oak Developments
The Bennett Brook Catchment Group
Canoble Park
Conservation Council of Western Australia Inc.
Edgecombe Bros Pty Ltd
JDA Consultants Hydrologists
North Ellenbrook Landowner's Group
Rocla Quarry Products
Sanwa Property Group
Swan Valley Nyungah Community
Wesley College Endowment Fund
Brajkovich Holdings Pty Ltd & Stefanelli Nominees Pty Ltd

**Members of the Public:**

W. Bestry
C. Dods
R. Gray
W. Kimba
M. Kailis & A. Kourtesis
K. Kirkby
J. & A Kourtesis, L Stambelos, J. Chaplin
W. Kuhn
G. & V Meakins
Mr. K Titelius
Vincent Nominees Pty Ltd
J. West

# Appendix 2

## References

Burbridge AH and Rolfe JK (1989) *Conservation status of the vegetaton types of the Swan Coastal Plain* Department of Conservation and Land Management, unpublished.

Dames and Moore (1986) Environmental Review and Management Programme *Gnangara Mound Groundwater Resources* Water Authority of Western Australia.

ecologia (1998) *Evaluation of Gnangara wetlands* Water and Rivers Commission

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Gibson N, Keighery BJ, Keighery GJ, Burbidge AH and Lyons MN (1994) *A floristic survey of the southern Swan Coastal Plain* Western Australian Dept of Conservation and Land Management and the Western Australian Conservation Council, unpublished.

Heddle EM, Loneragan OW and Havel JJ (1980) Vegetation complexes of the Darling System, Western Australia. In: *Atlas of natural resources Darling System, Western Australia.* Dept of Conservation and Environment, Perth.

Hill AL, Semeniuk CA, Semeniuk V and Del Marco A (1996) *Wetlands of the Swan Coastal Plain* Volume 2, Water and Rivers Commission and Department of Environmental Protection, Perth.

Jasinska EJ and Knott B (1994) *Aquatic fauna in the Gnangara Mound discharge areas of the Ellenbrook catchment,* WA Dept Zoology, University of Western Australia, Perth.

Trudgeon ME (1996) *An assessment of the conservation values of the remnant vegetation in the City of Wanneroo with recommendations for appropriate reserves in the City* City of Wanneroo, unpublished.

Trudgeon ME and Keighery BJ (1995) *A survey of the remnant vegetation of the City of Gosnells west of the Darling Scarp* City of Gosnells, unpublished.

Water Authority of Western Australia (1995) *Review of proposed changes to environmental conditions - Gnangara Mound Groundwater Resources* (Section 46).

Water and Rivers Commission (1997) Public Environmental Review *East Gnangara Environmental Water Provisions Plan* .

# Appendix 3

## List of recommended Ministerial Conditions and Proponent's consolidated commitments

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

EAST GNANGARA ENVIRONMENTAL WATER PROVISIONS PLAN

**Proposal:** The abstraction of groundwater for public and private water supply from the East Gnangara Mound, with provision for environmental water requirements, as documented in schedule 1 of this statement.

**Proponent:** Water and Rivers Commission

**Proponent Address:** 3 Plain Street, EAST PERTH WA 6004

**Assessment Number:** 932

**Report of the Environmental Protection Authority:** Bulletin 904

The proposal to which the above report of the Environmental Protection Authority relates may be implemented subject to the following conditions and procedures:

## 1 Implementation

1-1 Subject to these conditions and procedures, the proponent shall implement the proposal as documented in schedule 1 of this statement.

1-2 Where the proponent seeks to change any aspect of the proposal as documented in schedule 1 of this statement in any way that the Minister for the Environment determines, on advice of the Environmental Protection Authority, is substantial, the proponent shall refer the matter to the Environmental Protection Authority.

1-3 Where the proponent seeks to change any aspect of the proposal as documented in schedule 1 of this statement in any way that the Minister for the Environment determines, on advice of the Environmental Protection Authority, is not substantial, those changes may be effected.

## 2 Proponent Commitments

2-1 The proponent shall implement the consolidated environmental management commitments documented in schedule 2 of this statement.

2-2 The proponent shall implement subsequent environmental management commitments which the proponent makes as part of the fulfilment of conditions and procedures in this statement.

## 3 Proponent

3-1 The proponent for the time being nominated by the Minister for the Environment under section 38(6) or (7) of the Environmental Protection Act 1986 is responsible for the implementation of the proposal until such time as the Minister for the Environment has exercised the Minister's power under section 38(7) of the Act to revoke the nomination of that proponent and nominate another person in respect of the proposal.

3-2 Any request for the exercise of that power of the Minister referred to in condition 3-1 shall be accompanied by a copy of this statement endorsed with an

undertaking by the proposed replacement proponent to carry out the proposal in accordance with the conditions and procedures set out in the statement.

3-3 The proponent shall notify the Department of Environmental Protection of any change of proponent contact name and address within 30 days of such change.

## 4 Commencement

4-1 The proponent shall provide evidence to the Minister for the Environment within five years of the date of this statement that the proposal has been substantially commenced.

4-2 Where the proposal has not been substantially commenced within five years of the date of this statement, the approval to implement the proposal as granted in this statement shall lapse and be void. The Minister for the Environment will determine any question as to whether the proposal has been substantially commenced.

4-3 The proponent shall make application to the Minister for the Environment for any extension of approval for the substantial commencement of the proposal beyond five years from the date of this statement at least six months prior to the expiration of the five year period referred to in Conditions 4-1 and 4-2.

4-4 Where the proponent demonstrates to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority that the environmental parameters of the proposal have not changed significantly, then the Minister may grant an extension not exceeding five years for the substantial commencement of the proposal.

## 5 Compliance Auditing

5-1 The proponent shall submit periodic Performance and Compliance Reports, in accordance with an audit program prepared in consultation between the proponent and the Department of Environmental Protection.

5-2 Unless otherwise specified, Chief Executive Officer of the the Department of Environmental Protection is responsible for assessing compliance with the conditions, procedures and commitments contained in this statement and for issuing formal clearance.

5-3 Where compliance with any condition, procedure or commitment is in dispute, the matter will be determined by the Minister for the Environment.

## *Schedule 1*

### The Proposal

The WRC propose to allocate groundwater for abstraction from the eastern side of the Gnangara Mound to the Water Corporation and other uses, while allowing for provision of groundwater to the environment. Abstraction will provide for urban development in the north-east corridor in addition to supplementing the Perth metropolitan water supply, and groundwater for private users.

**Table 1. Key environmental criteria for terrestrial vegetation, wetlands and seepages in East Gnangara study area.**

| Location | Monitoring Well | EWR (min water level mAHD) | EWP (min water level mAHD) | EWP < EWR (m) |
|---|---|---|---|---|
| **Vegetation** | | | | |
| Melaleuca Park | WM6 | 58.8 | 58.3 | 0.5 |
| Melaleuca Park | WM8 | 65 | 64.8 | 0.2 |
| Melaleuca Park | NR6C | 58.5 | 58.5 | - |
| Melaleuca Park | WM2 | 67 | 66.5 | 0.5 |
| Melaleuca Park | NR11C | 55 | 55 | - |
| Whiteman Park | MM49B | 24.7 | 24.7 | - |
| Whiteman Park | MM53 | 33.3 | 33.3 | - |
| Whiteman Park | MM55B | 29.5 | 29.5 | - |
| Whiteman Park | MM18 | 38.6 | 38.6 | - |
| Whiteman Park | MM59B | 36.3 | 36.3 | - |
| Vegetation Corridor | MM12 | 43 | 42 | 1.0 |
| Vegetation Corridor | L30C | 47.5 | 47.2 | 0.3 |
| Vegetation Corridor | L110C | 57 | 55.7 | 1.3 |
| Vegetation Corridor | L220C | 52.5 | 52.2 | 0.3 |
| **Wetlands** | | **EWR [a] Minimum** | **Absolute minimum** | |
| Melaleuca Park 78 | GNM13 | 5.5m below ground | 5.8m below ground | |
| Melaleuca Park 173 | GNM14 | 0.1m above ground | 0.1m above ground | |
| Lexia 186 | GNM15 | 0.8m below ground | 1.1m below ground | |
| Lexia 86 | GNM16 | 1.0m below ground | 1.3m below ground | |
| Lexia 94 | GNM17A | 1.5m below ground | 1.8m below ground | |
| **Seepages** | | **EWR** | **EWP** | |
| Edgecombe | B10 | 14.35 [b] | [b] | |
| Egerton | B25 | 39.29 [c] | 39.29 [c] | |

a: Interim EWRs and absolute minimum water levels have been determined for these wetlands. EWPs will be provided following investigation of stratigraphy and water regimes, and reported in the triennial review.

b: Recommendation for management only. The seepage is outside the zone of influence of the proposal; final water levels are expected to be affected by factors unrelated to groundwater abstraction for public water supply.

c: Access to land required before monitoring can be conducted.

Locations of vegetation, wetlands and wells are provided in Figures 1, 2 and 3.

***Schedule 2***

# Proponent's Consolidated Environmental Management Commitments

September 1998

# EAST GNANGARA ENVIRONMENTAL WATER PROVISIONS PLAN(932)

Water and Rivers Commission

## Commitments

**1.** The Water and Rivers Commission will manage public and private groundwater abstraction to meet the water regime management objectives and Environmental Water Provisions (EWPs) summarised in Table A. The Water and Rivers Commission will also manage abstraction to meet the interim EWRs in Table B. As these EWRs are interim, they will be reviewed in the first triennial report to the EPA and updated as appropriate.

**2.** The Water and Rivers Commission will report on the management and monitoring of the Eastern Gnangara Mound to the EPA as part of existing reporting for the Gnangara Mound. Triennial reports will include information on the operation of groundwater schemes by the Water Corporation and private groundwater use, compliance with EWPs and environmental conditions and outline any environmental impacts. Annual reports will provide information on compliance with environmental conditions.

**3.** The Water and Rivers Commission will investigate stratigraphy and water regimes in the Lexia wetlands, EPP wetland 173 in Melaleuca Park and Melaleuca Park dampland 78. For wetlands displaying characteristics of perching the importance of groundwater to wetland water levels will be established and EWRs updated for the first triennial report to the EPA. EWPs will also be determined at this time.

**4.** The Water and Rivers Commission will support further research and investigations into the EWRs of wetlands, vegetation and seepage areas as defined in Section 16.5 of the PER document.

**5.** EWPs will be reviewed every six years in triennial reports or more frequently if necessary. Feedback, through the monitoring programme, of any unexpected impacts of groundwater abstraction will be used to update EWPs and water allocations if necessary. Any update will involve consultation with the EPA and incorporate public involvement.

**6.** The Water and Rivers Commission will, after receiving environmental approvals, implement and undertake the following monitoring programme to the satisfaction of the EPA and report results in annual and triennial reports to the EPA:

**6.1** Continue monitoring the network of wells on the East Gnangara Mound, at the frequency of 1 - 3 monthly depending on the well.

**6.2** Monitor water levels in terrestrial vegetation monitoring wells with EWPs monthly.

**6.3** Develop three new terrestrial vegetation transects on the East Gnangara Mound: one in Melaleuca Park and two in the Ellenbrook bushland near the Lexia wetlands, and monitor every three years.

**6.4** On a shared cost basis with the Whiteman Park Board of Management, recommence monitoring the terrestrial vegetation transect established in 1991 by WAWA in Whiteman Park.

**6.5** Continue monitoring the terrestrial vegetation transect established in 1966 in Melaleuca Park, at a 3 - 6 year frequency.

**6.6** At each of the terrestrial vegetation transects, select a range of species which provide an indication of vegetation composition. The indicator species will be monitored in Spring every three years to assess any change towards a drier community. Parameters that will be assessed include; age (size), class distribution, vigour and recruitment.

**6.7** Calculate a similarity index for each transect at each monitoring period with the aim of summarising spatial and temporal changes in vegetation composition.

**6.8** For each terrestrial vegetation transect on the Eastern Gnangara Mound determine an 'acceptable' rate of change in vegetation composition. Rates of change will be measured using indicator species and similarity indices.

**6.9** Monitor water levels monthly in wetlands and/or in nearby monitoring wells for the following wetlands:

Lexia wetland 94;

Lexia wetland 186;

Lexia wetland 86;

Melaleuca Park Dampland 78;

EPP wetland 173; and

Lake Yakine (located east of Edgecombe seepage).

**6.10** Develop vegetation transects in each of the wetlands listed in Commitment 6.9 (with the exception of Lake Yakine). Monitoring will be undertaken in Spring of the first three years and reviewed in the first triennial report.

**6.11** Conduct baseline monitoring on aquatic invertebrates and water quality in the Lexia wetlands. Findings will be published in the first annual report.

**6.12** Monitor aquatic invertebrate fauna and water quality in the wetlands listed in Commitment 6.9 which contain open water, in Spring each year.

**6.13** Map wetland habitats along a regional transect in Melaleuca Park in Spring using large scale aerial photography annually for the first three years, then every three years.

**6.14** Monitor water levels in the Egerton and Edgecombe seepages and upstream of the seepages on a monthly basis (once access is granted).

**6.15** Provided access is granted, conduct baseline monitoring of aquatic invertebrate fauna and water quality in the Egerton seepage. Results will be given in the first triennial report.

**6.16** Monitor aquatic invertebrate fauna and water quality in the Egerton and Edgecombe seepages annually in Spring (once access is granted)

**6.17** Monitor water levels in wells with EWPs more frequently than once a month where necessary to determine compliance with provisions.

**7.** The Water and Rivers Commission will consult with CALM to endeavour to develop a Memorandum of Understanding (MOU) on pine management regimes in State Forest 65 which recognises the dual use of forests and optimises water and timber production, while minimising environmental impacts. The MOU will include agreements associated with the removal of the pine plantation over the next 20 years and the proposed establishment of Gnangara Park. In the process of developing the MOU, further modelling studies will investigate the impact of the various scenarios of pine removal on water tables. This will include consideration of how the 'extra water' could be 'allocated' between consumptive and ecosystem protection uses.

**8.** The Water and Rivers Commission will provide advice on the impact of land-uses on groundwater resources of the Gnangara Mound to relevant agencies.

**9.** The Water and Rivers Commission will determine EWPs for new wells in the native vegetation corridor which have been installed at more appropriate places to replace wells MM12, L30C, L110C and L220C once sufficient monitoring data is available from the new wells.

**10.** The Water and Rivers Commission will continue to chair and provide support for a Consultative Committee as a forum of information exchange and to provide advice to the Water and Rivers Commission in relation to management of water on the Gnangara Mound. A reduced number of members representing each of the East Gnangara and Gnangara Committees will be combined to form one Consultative Committee for the Gnangara Mound.

**11.** The Water and Rivers Commission will require the Water Corporation, through licence conditions, to phase in the production wells closest to phreatophytic vegetation to allow the

vegetation to adapt slowly to the drawdown and minimise the overall impacts of drawdown.

**12.** The Water and Rivers Commission will require the Water Corporation to develop and implement a mitigation strategy to:

- identify actions to minimise loss of values, prior to development,
- monitor wetlands to determine whether loss of values has occurred, on an ongoing basis, and
- compensate for any loss of values in the event of adverse impacts becoming apparent

for the conservation category wetlands 132, 156, 158 and 164 and the *Melaleuca rhaphiophylla* wetland (104) in the pine plantation, on the advice of the WRC and the DEP.

**13.** The Water and Rivers Commission will within six months of receiving environmental approval, require that the Water Corporation, through licence conditions, update their operations plan to include the Lexia and East Mirrabooka groundwater schemes. This will include environmental management of the schemes and details of how abstraction will be managed to meet EWPs. As part of the operating strategy the Water Corporation will be required to submit annual production plans.

**14**. To assist with future groundwater management and water supply planning the Water and Rivers Commission will map vegetation communities on the Gnangara Mound. This will be done through the following process in consultation with the Department of Environmental Protection.

1. Determine the procedures required to undertake mapping of vegetation communities on the Mound;
2. Use the procedures to develop a programme for mapping communities; and
3. Undertake mapping to the satisfaction of the Department of Environmental Protection.

**15.** The Water and Rivers Commission will monitor water levels monthly and establish a vegetation transect in wetland 132 in the vegetation corridor. The vegetation transect will be monitored in Spring of the first three years to gain information on the impacts of drawdown on the vegetation. The monitoring will then be reviewed in the first triennial report. The monitoring will be undertaken to gain information on early indicators of drawdown impacts.

**16**. The Water and Rivers Commission will liaise directly with the Swan Valley Nyungah Community regarding the proposal.

**TABLE A. Environmental Criteria**

| WELL | LOCATION | Environmental Water Provisions (EWPs) | | |
|---|---|---|---|---|
| | | Management Objective | Minimum water level (mAHD) | Absolute minimum water level (mAHD) |
| WM6 | Melaleuca Park | Protect native vegetation from any further groundwater abstraction impacts | 58.3 | * |
| WM8 | Melaleuca Park | Protect native vegetation from any further groundwater abstraction impacts | 64.8 | * |
| NR6C | Melaleuca Park | Protect native vegetation from any further groundwater abstraction impacts | 58.5 | * |
| WM2 | Melaleuca Park | Protect native vegetation from any further groundwater abstraction impacts | 66.5 | * |
| NR11C | Melaleuca Park | Protect native vegetation from any further groundwater abstraction impacts | 55 | * |
| MM49B | Whiteman Park | Protect native vegetation from any further groundwater abstraction impacts | 24.7 | * |
| MM53 | Whiteman Park | Protect native vegetation from any further groundwater abstraction impacts | 33.3 | * |
| MM55B | Whiteman Park | Protect native vegetation from any further groundwater abstraction impacts | 29.5 | * |
| MM18 | Whiteman Park | Protect native vegetation from any further groundwater abstraction impacts | 38.6 | * |
| MM59B | Whiteman Park | Protect native vegetation from any significant groundwater abstraction impacts | 36.3 | * |
| MM12 | Native vegetation corridor | Protect native vegetation but allow a slow change to a drier community structure | 42 | * |
| L30C | Native vegetation corridor | Protect native vegetation but allow a slow change to a drier community structure | 47.2 | * |
| L110C | Native vegetation corridor | Protect native vegetation but allow a slow change to a drier community structure | 55.7 | * |
| L220C | Native vegetation corridor | Protect native vegetation but allow a slow change to a drier community structure | 52.2 | * |
| GNM13 | Dampland 78[1] - Melaleuca Park | Maintain existing areas of wetland vegetation | ** | ** |
| GNM14 | EPP 173 - Melaleuca Park | •Maintain existing areas of wetland and stream<br>• Maintain existing areas of wetland | ** | ** |

| | | | | |
|---|---|---|---|---|
| | | vegetation<br>•Protect invertebrate communities dependent on the wetland and stream<br>• Protect the fish, *Galaxiella nigrostrata* | | |
| GNM15 | Lexia wetland 186 | •Protect current vegetation assemblages in and fringing the wetland<br>• Protect any aquatic invertebrate fauna dependent on the wetland | ** | ** |
| GNM16 | Lexia wetland 86 | •Protect current vegetation assemblages in and fringing the wetland<br>• Protect any aquatic invertebrate fauna dependent on the wetland | ** | ** |
| GNM17A | Lexia wetland 94 | Protect current vegetation assemblages in the wetland | ** | ** |
| B25 | Egerton seepage | Maintain a permanent flow of water in the seepage | 39.29 *** | * |

* *not applicable*

** *interim EWRs have been determined for these wetlands . EWPs will be determined following investigation of stratigraphy and water regimes, and reported in the triennial review.*

*** *Cannot be monitored until access to the land granted*

[1] wetland reference numbers from WRC PER document.

**Table B. Interim Environmental Water Requirements**

| Wetland | Interim Environmental Water Requirement[1] | |
|---|---|---|
| | Minimum | Absolute minimum |
| Lexia wetland 1 (94) | 1.5m below ground (45.8 mAHD -well GNM 17A) | 1.8m below ground (45.5 mAHD - well GNM 17A) |
| Lexia wetland 2 (86) | 1m below ground (47.3 mAHD - well GNM 16) | 1.3m below ground (47 mAHD - well GNM 16) |
| Lexia wetland 3 (186) | 0.8m below ground (47.5 mAHD - well GNM 15) | 1.1m below ground (47.2 mAHD - well GNM 15) |
| EPP wetland 173 | 0.1m above ground (in western sector) | |
| Dampland 78 | 5.5m below ground (65.4 mAHD - well GNM 13) | 5.8m below ground (65.1 mAHD - well GNM 13) |

1. Note that these EWRs are be necessity, interim, due to a range of difficulties in establishing appropriate criteria taking into account "perching" of water levels and accurate survey information. Final criteria monitoring points are still to be established in some wetlands.

**EAST GNANGARA ENVIRONMENTAL WATER PROVISIONS PLAN ENVIRONMENTAL MANAGEMENT COMMITMENTS**

| Commit-ment number | Commitment (What) | Objective (Why) | Action (How/ Where) | Timing (When) | Whose advice (to Whom) | Measurement/ Compliance criteria |
|---|---|---|---|---|---|---|
| 1. | Manage public & private groundwater abstraction to meet objectives and EWPs | As per column 3 of table A | As per column 4 in table A (& columns 3&4 in table B) | Ongoing<br>particularly summer/ autumn | DEP | Annual/ Triennial reports & as necessary |
| 2. | Prepare annual & triennial reports | Report on compliance, impacts, review abstraction & criteria etc | Review abstraction, monitoring etc | annually, triennially | DEP | Annual/ Triennial reports |
| 3. | Investigate water regimes and stratigraphy in Lexia wetlands, and wetland 173 and dampland 78 in Melaleuca Park | To identify if perched, degree of dependence on groundwater, and to confirm EWRs | By a drilling and monitoring programme | In first 3 years following project approval | DEP | First triennial report |
| 4. | Conduct research on EWRs | Improve knowledge | provide support to research projects, conduct investigations | ongoing<br>major vegetation project will finish end 1999 | DEP | Triennial reports |
| 5. | Review EWPs | Adaptive management - incorporate new knowledge. | By monitoring / research | Six yearly or more frequently as necessary | DEP | Triennial reports & as necessary |
| 6. | Implement monitoring programme | Feedback to EWPs | water level, vegetation, and invertebrate monitoring as outlined 6.1-6.17 in document. | monthly, yearly, triennially & ongoing. | DEP | Annual & Triennial reports & as necessary. |
| 7. | Determine pine management | Optimise water and timber production/ | Develop an MOU with CALM which include | June 1998 | DEP | MOU and monitoring |

| | | | | | | |
|---|---|---|---|---|---|---|
| | regime for SF65 | development of Gnangara Park while minimising environmental impacts | pine harvesting over 20 years and Gnangara park establishment | | | results in annual reports |
| 8. | Provide advise on impacts of landuse on groundwater resources | Assist protection/ management groundwater resources | Provide advice as required | Ongoing | Relevant agencies, especially Shire of Swan and MFP. | - |
| 9. | Determine EWPs for new, appropriately located, wells in the vegetation corridor | To assist groundwater resource management and to be in compliance with EWPs for new wells | Collect and review monitoring data | In first 3 years following project approval | DEP | annual report |
| 10. | Chair Consultative Committee for the Gnangara Mound | To exchange information/advice with stakeholders | Conduct meetings at local shire | Annually | local government, relevant government agencies, conservation and community groups | Meeting minutes and brief documentation in triennial reports. |
| 11. | Production wells close to phreatophytic vegetation to be appropriately phased in by Water Corporation | To allow vegetation to adapt to groundwater drawdown | Include requirement in licence conditions | When groundwater licence for Lexia wells provided. | Water Corporation<br>DEP | Licence conditions.<br>Annual reports by Water Corporation. |
| 12. | Require the Water Corporation to develop and implement a wetland mitigation strategy for the *M. rhaphiophylla* wetland in the | To mitigate for large drawdowns and predicted significant impact on this | Assist with determining an appropriate wetland mitigation strategy and include requirement in | Develop strategy prior to commissioning of Lexia wellfield and implement actions | Water Corporation<br>CALM | Licence conditions |

| | | | | | | |
|---|---|---|---|---|---|---|
| | pine plantation. | wetland. | licence conditions | as necessary to avoid or compensate loss of values as impacts become apparent | DEP | |
| 13. | Require the Water Corporation to prepare operations plans (with environmental commitments to meet EWPs) for the Lexia and East Mirrabooka groundwater schemes | To ensure WC's operation of groundwater schemes complies with WRC's environmental conditions/commitments on EWPs | Include requirement for operations plan in licence conditions. | In 6 months following project approval and prior to commissioning of the Lexia wellfield | DEP | Licence conditions<br>Operations Plan |
| 14. | Map vegetation community types on the Gnangara Mound. | To assist future groundwater management and water supply planning | Develop and undertake a vegetation mapping programme | To be determined in development of mapping programme which will be submitted 3 months after approvals of the East Gnangara Plan obtained | DEP | Mapping programme and maps |
| 15 | Monitor water levels and vegetation in wetland 132 | To obtain information on drawdown impacts | Monitor water levels monthly & vegetation transect in Spring | Establish monitoring prior to commissioning of wellfeild and conduct for 3 years then review | DEP | *Licence conditions* Annual / Triennial reports. |
| 16 | Liaise with Aboriginal community | Provide an understanding of the proposal and how it relates to Aboriginal issues | WRC will consult directly with Swan Valley Nyungah Community | In 6 months following project approval and prior to commissioning of Lexia wellfeild | DEP | Meeting minutes & brief documentation in annual report. |