Government of **Western Australia**
Department of **Water**

SouthWest

groundwater areas allocation plan

Looking after all our water needs

Water resource allocation
and planning series
Report no. 21
May 2009

SouthWest

groundwater areas allocation plan

Department of Water
Water resource allocation
and planning series
Report no. 21
May 2009

Department of Water
Water resource allocation planning series
Report no. 21

May 2009

Department of Water
168 St Georges Terrace
Perth Western Australia 6000
Telephone +61 8 6364 7600
Facsimile +61 8 6364 7601
www.water.wa.gov.au

ISSN 1327-8428 (print)
ISSN 1834-2620 (online)

ISBN 978-1-921094-96-5 (print)
ISBN 978-1-921094-97-2 (online)

Acknowledgements

The Department of Water would like to acknowledge the following for their contribution to this publication: the South West groundwater areas project team and regional staff, in particular the major contributors Patrick Seares, Rebecca Palandri, Natasha Del Borrello, Adrian Goodreid, Travis Cattlin, Penny Wallace-Bell, Gary Floyd, Phil Commander, Bev Thurlow, Annaleisha de Chanéet, Mick Owens and Richard Watson.

For more information about this report, contact:

Regional manager,
South West regional office
35–39 McCombe Road
Bunbury Western Australia 6230
or
PO Box 261
Bunbury Western Australia 6231

Telephone 08 9726 4111
Facsimile 08 9726 4100

Foreword

This plan provides water users and the wider community with the Department of Water's management approach for allocating groundwater in the south-western corner of the state.

Our goal is to manage the water resources in the best interests of the whole community, considering carefully the competing demands of regional development and protection of the South West's natural assets. This goal is becoming ever more challenging in the context of a variable climate.

This plan aims to ensure that the amount of water made available provides users with security in their entitlements, while at the same time protecting the environment of the South West that we all value. The department hopes that one of the results of this plan will be that people will use their water more efficiently as they increasingly recognise it for the valuable resource it is.

Kim Taylor
Director General, Department of Water

Contents

Contents

Contents

Contents

Figures

Tables

Summary

What is this all about?

The Department of Water manages how much water is taken from rivers and groundwater systems by developing water allocation plans.

This plan sets out where water is available, the policies for how all groundwater abstraction and use will be managed in the area, and how the ecological, social and economic needs for water have been considered. The plan also provides for water trading in fully allocated resources.

Why are we doing this?

The work for this plan began in response to the now withdrawn proposal to abstract 45 GL/yr from the Yarragadee Aquifer for the Integrated Water Supply Scheme. Although this proposal is not proceeding, it highlighted the fact that the South West should be treated as a priority area of the state. This means that closer management will be needed, based on a better understanding of the groundwater system, the effects of declining rainfall and increased demand.

This plan sets out a consistent approach to allocation and licensing within the area. It shows the major considerations we addressed in providing security of supply to current users and the environment, while assessing the amount of water available for new commercial and private users.

What is the picture for the South West groundwater area and its water resources?

The South West is experiencing climate change resulting in less recharge from rainfall reaching the groundwater system every year. There has also been growth in the number of people living in the area, as well as in commerce and local industries. All rely on secure water supplies. There are currently around 4000 licences to abstract groundwater within the area.

This plan covers the important Yarragadee Aquifer as well as other groundwater resources, including the Leederville and Superficial aquifers. The water levels in some of these aquifers are decreasing due to reduced rainfall and higher abstraction. In some of the northern aquifers the recycling of salt through irrigation is having an impact on groundwater quality.

The environment in the South West is highly valued by the community as well as being recognised for its outstanding biodiversity. Key features, such as some of the Blackwood River tributaries and important coastal plain wetlands and lakes, have been identified for careful management. Currently the environment is sustained by the existing water level regime, but increased abstraction on top of the predicted reductions in rainfall could result in future adverse effects.

Summary

How are we managing the South West groundwater areas?

This plan defines allocation limits which set how much water is available for use annually from groundwater resources in the area. In some parts of the South West current water use has reached the full allocation limit. In other areas there is water available for further use.

The environment is protected by this plan. The allocation limits have been set to minimise the predicted risk to wetlands and rivers while sustaining reasonable growth in the region. The environmental monitoring program and the impact management policies in this plan outline how risk is managed on a local basis, to avoid unacceptable impacts from water abstraction.

This plan ensures that there is enough water to secure supply to existing licensed users. This means that in some areas the allocation limits have been decreased in response to our improved understanding of reducing rainfall, the environment and hydrogeology. Water has not been made available in areas where it could lead to an increased risk of restrictions on existing licensees.

Water has been reserved to ensure clean, safe drinking supplies are available for local towns to expand, provided this water is used efficiently.

Water will not be allocated above the allocation limits as set in this plan. This means that to continue developing in some parts of the region, with limited water available, new and existing commercial water users will have to consider how they can use water more efficiently, use alternative supplies, find fit for purpose water or trade water. This is particularly true with the Yarragadee Aquifer.

In areas of full allocation the plan promotes trading. Water users are encouraged to be more efficient so that others can buy these water efficiency gains to sustain regional commercial development.

Any amendments to the current allocation limits, or where additional allocation of water is found to be sustainable through future investigations, will be released through an appropriate mechanism to be announced by the department.

How did we develop this plan?

Work on the South West groundwater area allocation plan effectively began in late 2002 as part of the assessment of the South West Yarragadee licence application.

The department has used the best information there is available to develop this plan. The Department of Water and the Water Corporation have completed groundwater investigations and modelling as well as ecological assessments, community consultation, water user surveys and assessments of monitoring data. The supporting technical work represented a significant investment by the government in this part of the state.

Recognising that there are still gaps in this priority area of the state, the department aims to improve our knowledge and management. Over $7 million has been invested through joint funding between the department and the federal government for further work over the next three years. This new work will ensure that the water resources of the South West are understood and managed effectively. The work will inform the development of a new plan by 2011.

How have we considered the public's submissions in finalising the plan?

This plan has been improved by considering the public's submissions received through the draft consultation period. Please see the department's *Statement of response – South West groundwater areas allocation plan*, DoW 2009f for more information on the department's response to the comments received and how the plan has been updated.

Part one

South West groundwater areas

Chapter one

The South West groundwater areas allocation plan

1.1 Purpose of the plan

This water allocation plan explains the Department of Water's direction on the taking and use of groundwater resources in the South West groundwater areas. The planning process considered the ecological, social and economic values of the water resources and the community's input over several years, through a range of consultation processes. It aims to achieve a balance between current and future users, and the protection of the groundwater-dependent environment.

The plan aims to meet the need of current and future water users for clear and consistent direction about water use in areas that are under pressure from increasing abstraction and climate change.

This plan has been developed in response to the following needs:

- the need for a response to the proposed abstraction of 45 GL/yr from the Yarragadee Aquifer for the Integrated Water Supply Scheme (IWSS) (see Box 1)
- the need for a consistent approach to water management in the South West
- the need to provide certainty to current water users on water availability and security
- the clear community concern over water management and the environment.

The plan explains how the department will manage:

- the potential effects of declining rainfall in the South West
- existing and potential environmental impacts from water abstraction
- increased water demand for irrigation and other regional industries
- increased growth in south-western towns and subsequent public water supply demand.

This plan details:

- the South West groundwater areas allocation planning boundaries, by groundwater subarea and resource
- the allocation limit, the amount of groundwater already licensed and the amount available for allocation
- how groundwater will be allocated between competing uses
- the monitoring strategies needed to improve our understanding of the resource, important groundwater-dependent ecosystems (GDE) and the impacts of current and future use
- the water management framework including:
  - the principles and objectives (or targets) for water use and management
  - policies to manage water abstraction and use to help achieve these objectives
  - how the plan will be reviewed and evaluated.

1.2 Principles underlying the plan

The broader strategic principles for water management are defined in the *South West Regional Water Plan – Strategic direction, draft for public comment* (DoW 2008b) and apply to the plan area. The following principles form the basis for operational policies and licensing decisions in the South West groundwater areas. They will be considered in all current and proposed operations, where water is used or there are impacts on the resource.

- The environment has a right to water. Abstraction of groundwater must not place key ecological values at an unacceptable level of risk.
- Existing users' security of supply should not be unacceptably reduced by making more water available for new users.
- Water is a valuable resource and should be used as efficiently as possible to maximise regional and state development.
- Everyone has the right to clean drinking water.
- Ecological, social and cultural groundwater-dependent values must be identified and predicted impacts to them accounted for in water allocation decisions.
- Water users and the wider community should be advised about data collected by monitoring and about the ongoing management and future planning of their water resources, and will have their concerns documented and considered in decision making.
- Adaptive management should be used to ensure that, as the water resource situation changes, the level of management will be adjusted accordingly.

1.3 The plan area

The South West groundwater areas include the proclaimed groundwater areas of Bunbury, Busselton–Capel, and Blackwood plus the southern part of the South West Coastal groundwater area. The plan area also includes two portions of unproclaimed areas (Karri–Blackwood and Karri–Bunbury groundwater subareas) (Figure 1). The plan covers all groundwater resources in the proclaimed areas but it only applies to artesian groundwater in the unproclaimed areas. The plan covers a large area of approximately 8250 km^2.

Resources

The groundwater resources located in the South West groundwater areas are the Superficial, Leederville, Yarragadee, Lesueur Sandstone, Sue Coal Measures, Cattamarra Coal Measures and fractured rock aquifers. These resources are described in Chapter 2 and detailed information on each of these resources is contained in the reports listed in the bibliography.

The plan applies to surface water expressions of groundwater (that is, wetlands or riverine base flows) where these are dependent on groundwater, and any management decisions regarding groundwater must consider these situations. Surface water management for this area is covered in the *Whicher area surface water allocation plan* (DoW 2009a).

Box 1: The South West Yarragadee proposal for Integrated Water Supply Scheme supply

In 2002 the Water Corporation began the process of applying for a licence to abstract 45 GL/yr from the Yarragadee Aquifer. This water was to be used to supply the Integrated Water Supply Scheme which provides water for Perth, the Wheatbelt, some south-western towns and the Goldfields. The hydrogeological understanding at the time indicated that the aquifer may have been able to supply this water sustainably.

Considerable investigation and modelling of the system was carried out and in early 2007 the Environmental Protection Authority determined that the proposal was environmentally acceptable subject to a number of stringent conditions. This work also identified the concern that if the pattern of declining rainfall were to continue it may affect the long-term security of this supply.

In 2007 the Government of Western Australia determined that the preferred option for supplying the Integrated Water Supply Scheme was a climate independent desalination plant. This decision made the Yarragadee proposal unnecessary.

However, the investigations carried out for the Yarragadee proposal have not been wasted. The knowledge gained has contributed to the development of this plan by improving our understanding of the groundwater system. It has enabled us to plan for the sustainable management of groundwater resources in the face of increasing pressure from regional water supply and commercial demands on both the resources and on the environment of the South West.

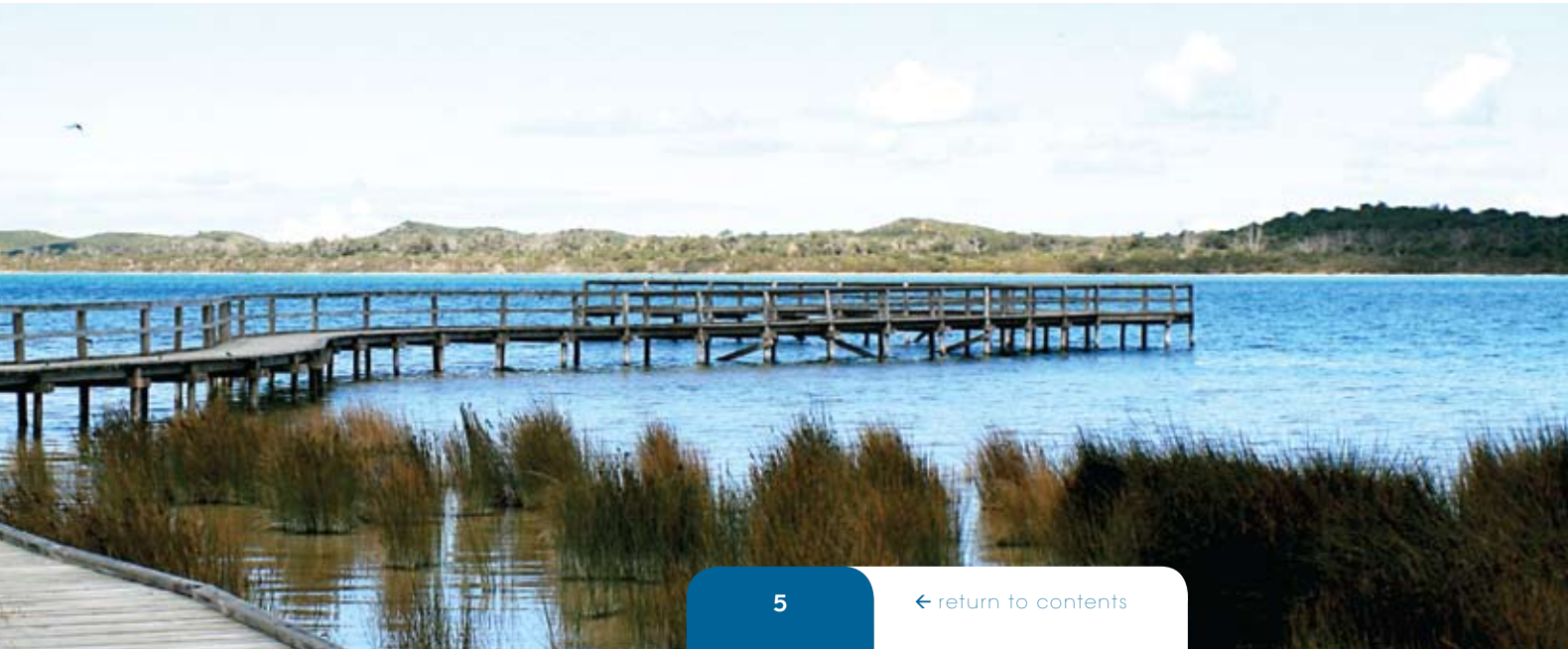
A separate plan for the Kemerton subareas

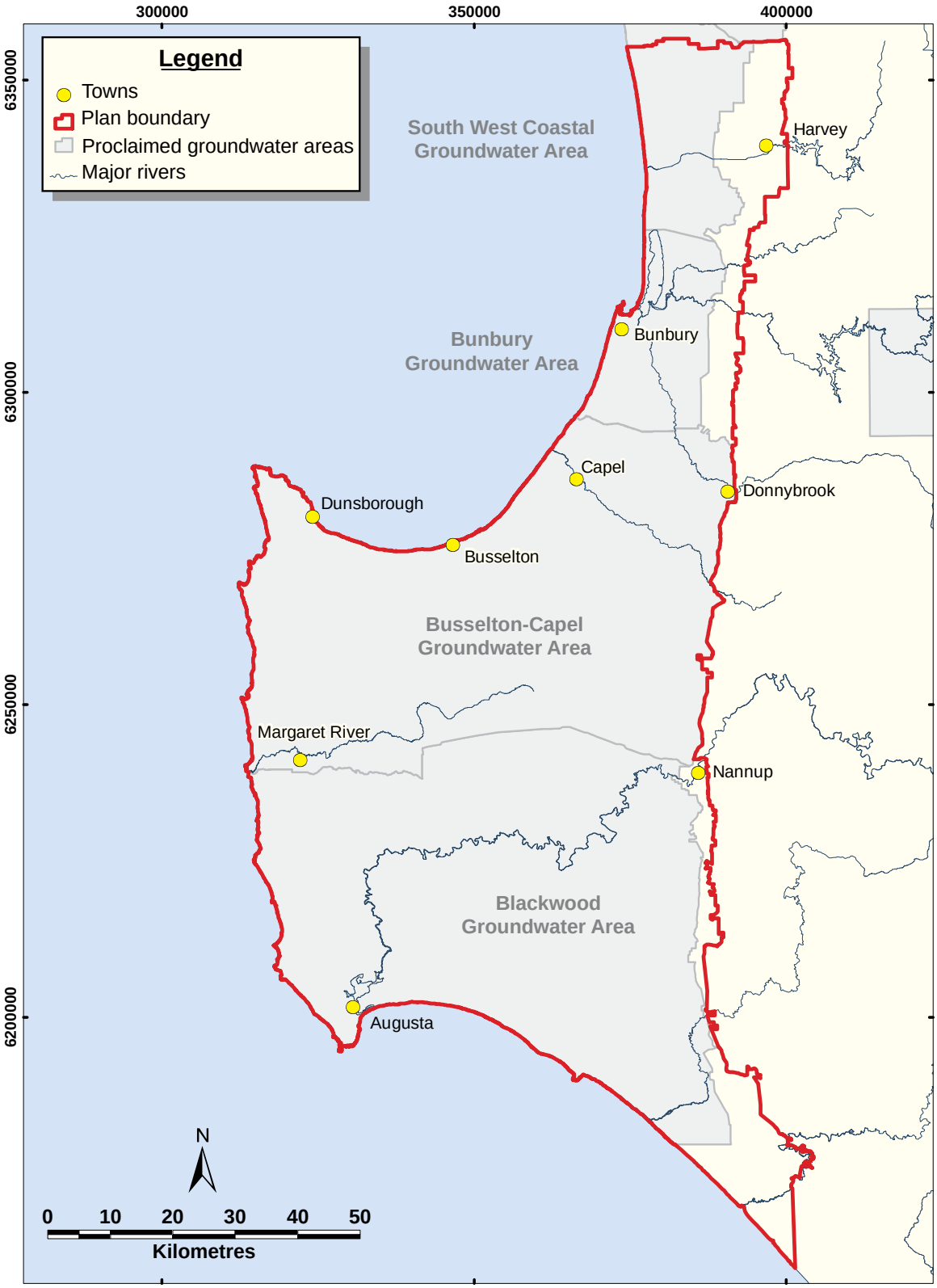
Part of the South West groundwater areas is also managed under the *Kemerton groundwater subareas water management plan* (DoW 2007c). The Kemerton plan provides local area management policies and rules for the Kemerton Industrial Park and surrounding areas. Both plans apply to this area (shown in green in Figure 10 and Figure 11).

1.4 Water allocation planning and water reform

In 2006 the Government of Western Australia became a signatory to the National Water Initiative, Australia's national blueprint for water reform, to which all state and territory governments are committed. The National Water Initiative recognises the importance of increasing the productivity and efficiency of Australia's water use, ensuring efficient water services to both rural and urban communities and protecting the health of surface and groundwater systems.

This *South West groundwater areas allocation plan* sets out how the groundwater resources will be allocated and managed until a statutory plan is completed by 2011 under the proposed new water resources management legislation. These new statutory plans will be consistent with the intent of the National Water Initiative.





Locality map

Government of Western Australia
Department of Water

This map is a product of the Dept of Water, Water Resource Use Division and was printed on 13/02/2009.

While the department has made all reasonable efforts to ensure the accuracy of this data, the department accepts no responsibility for any inaccuracies and persons relying on this data do so at their own risk.

Sources

DoW acknowledges the following datasets and their Custodians in the production of this map:

Western Australia Towns – DLI – 2003
Global Map Data Australia 1M – GA – 30/06/2001
Plan_Boundary – DoW – 05/11/2007
RIWI Act, Groundwater Areas – DoW – 06/03/2008
Hydrography, Linear (Hierarchy) – DoW – 08/06/2006

Datum & projection information

Vertical datum: AHD
Horizontal datum:GDA 94
Projection: MGA 94 Zone 50

Project information

Requestee: Rebecca Palandri
Map Author: Brenden Huntley
Filename J:\pp\wa\C2106\0007\mxd\090213_SWGA_Plan Area.mxd
Date: 13/02/2009

Figure 1
Proclaimed groundwater areas in the plan area

Chaptertwo

Considerations for water management

2.1 Hydrogeology

The South West groundwater areas cover a large area of complex hydrogeology (Figure 2 and 3, and Appendix A). The aquifers have been grouped into several hydrogeological units for management purposes. The combination of the various layers (or members) within a hydrogeological formation (for instance Leederville Aquifer – Vasse, Quindalup and Mowen members) is based on factors including age of the geological layers, distinctive rock and sediment characteristics, hydraulic connectivity between the layers and separation by major confining layers.

The hydrogeology in some areas leads to surface expressions of groundwater which maintain important environmental features. This can be a wetland or stream where the Superficial Aquifer nears the surface, or areas where the Yarragadee and Leederville aquifers outcrop at the surface or discharge water into a watercourse to maintain flows or pools through the summer months. The concept of recharge rates and storage capacity of aquifers is discussed in Box 2.

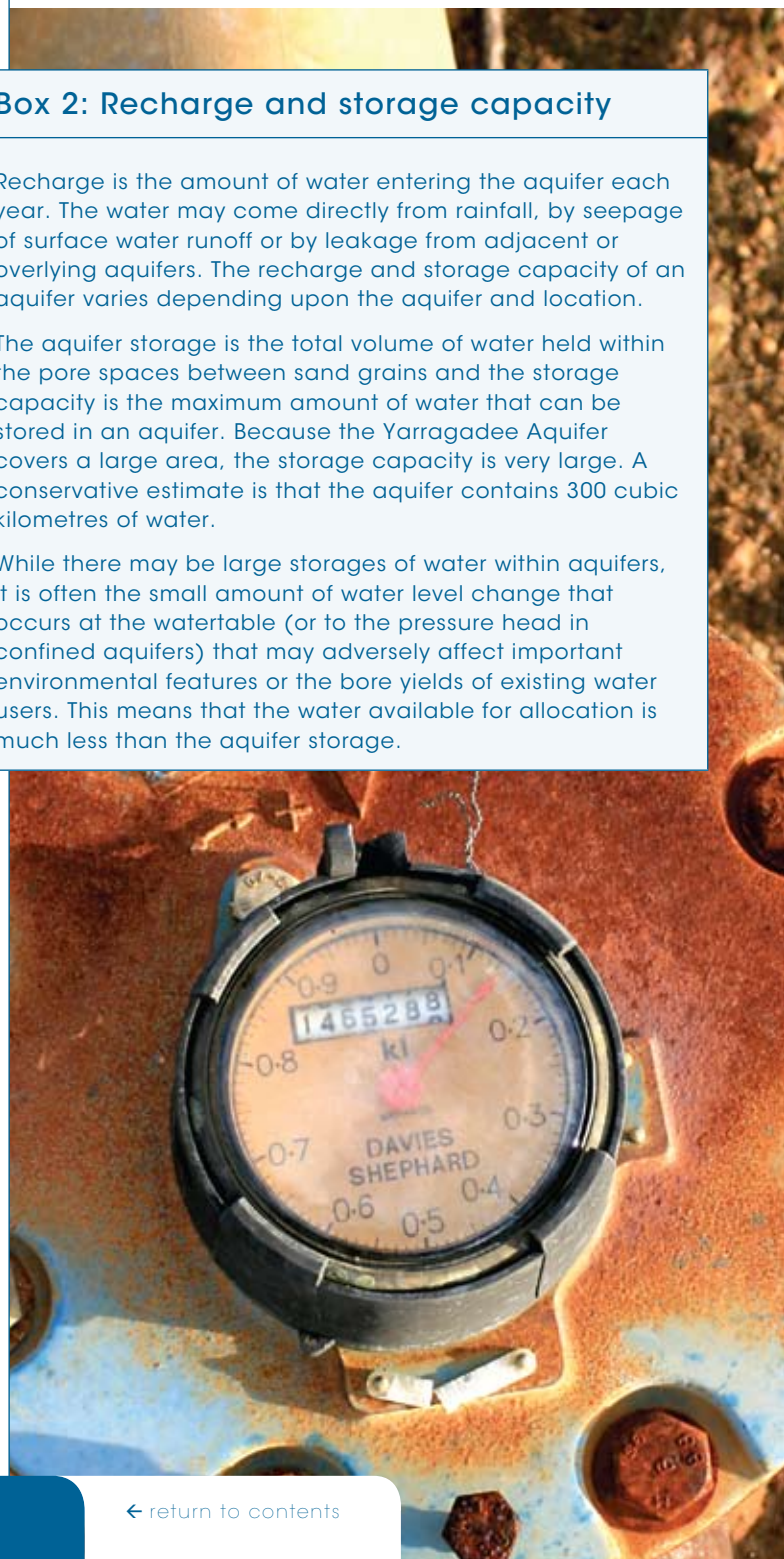
Information on the hydrogeological characteristics of the aquifers and geological formations summarised in this section are described in detail in the various reports listed in the bibliography. Hydrogeological and geological maps are also presented in Appendix A.

Box 2: Recharge and storage capacity

Recharge is the amount of water entering the aquifer each year. The water may come directly from rainfall, by seepage of surface water runoff or by leakage from adjacent or overlying aquifers. The recharge and storage capacity of an aquifer varies depending upon the aquifer and location.

The aquifer storage is the total volume of water held within the pore spaces between sand grains and the storage capacity is the maximum amount of water that can be stored in an aquifer. Because the Yarragadee Aquifer covers a large area, the storage capacity is very large. A conservative estimate is that the aquifer contains 300 cubic kilometres of water.

While there may be large storages of water within aquifers, it is often the small amount of water level change that occurs at the watertable (or to the pressure head in confined aquifers) that may adversely affect important environmental features or the bore yields of existing water users. This means that the water available for allocation is much less than the aquifer storage.



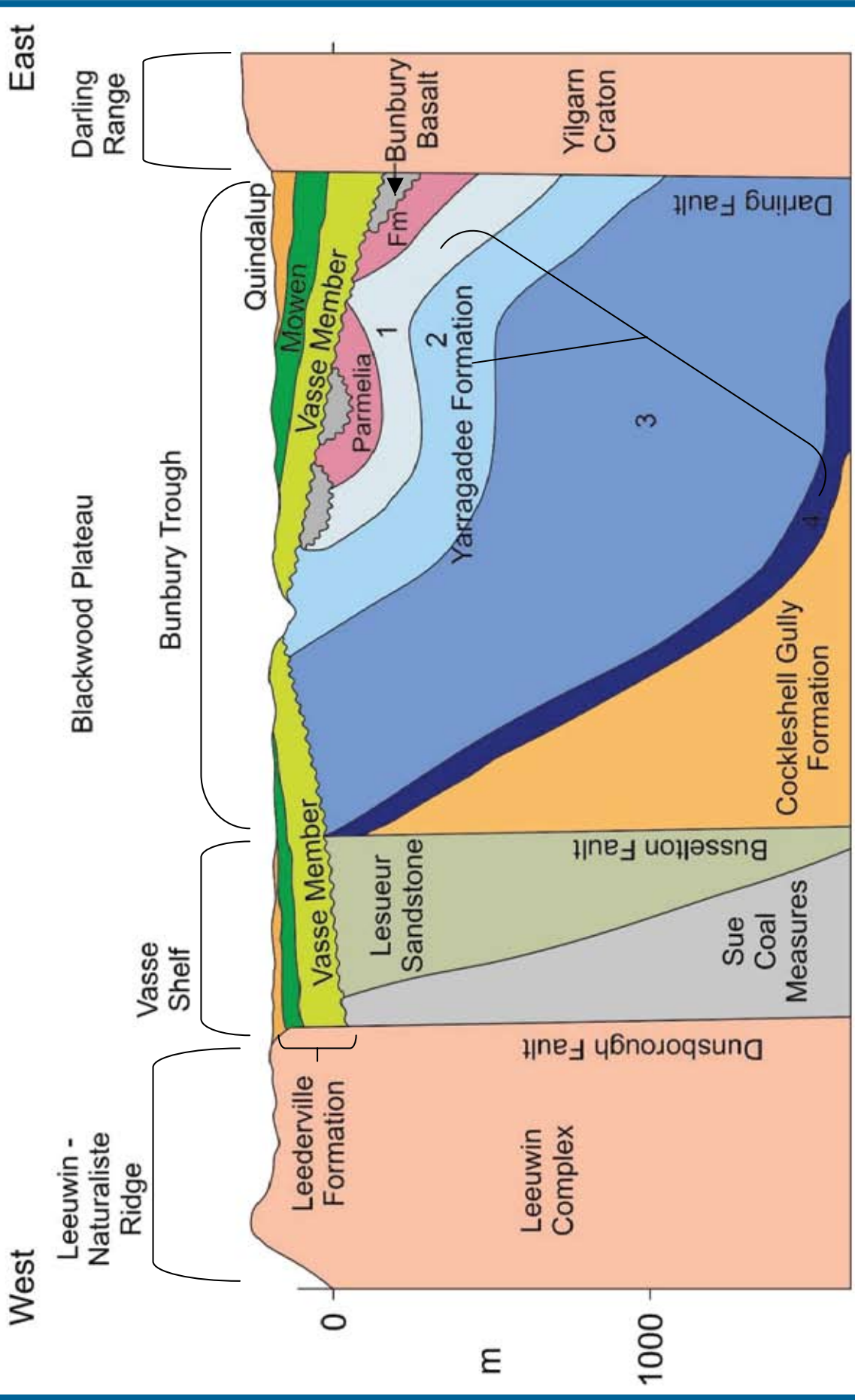
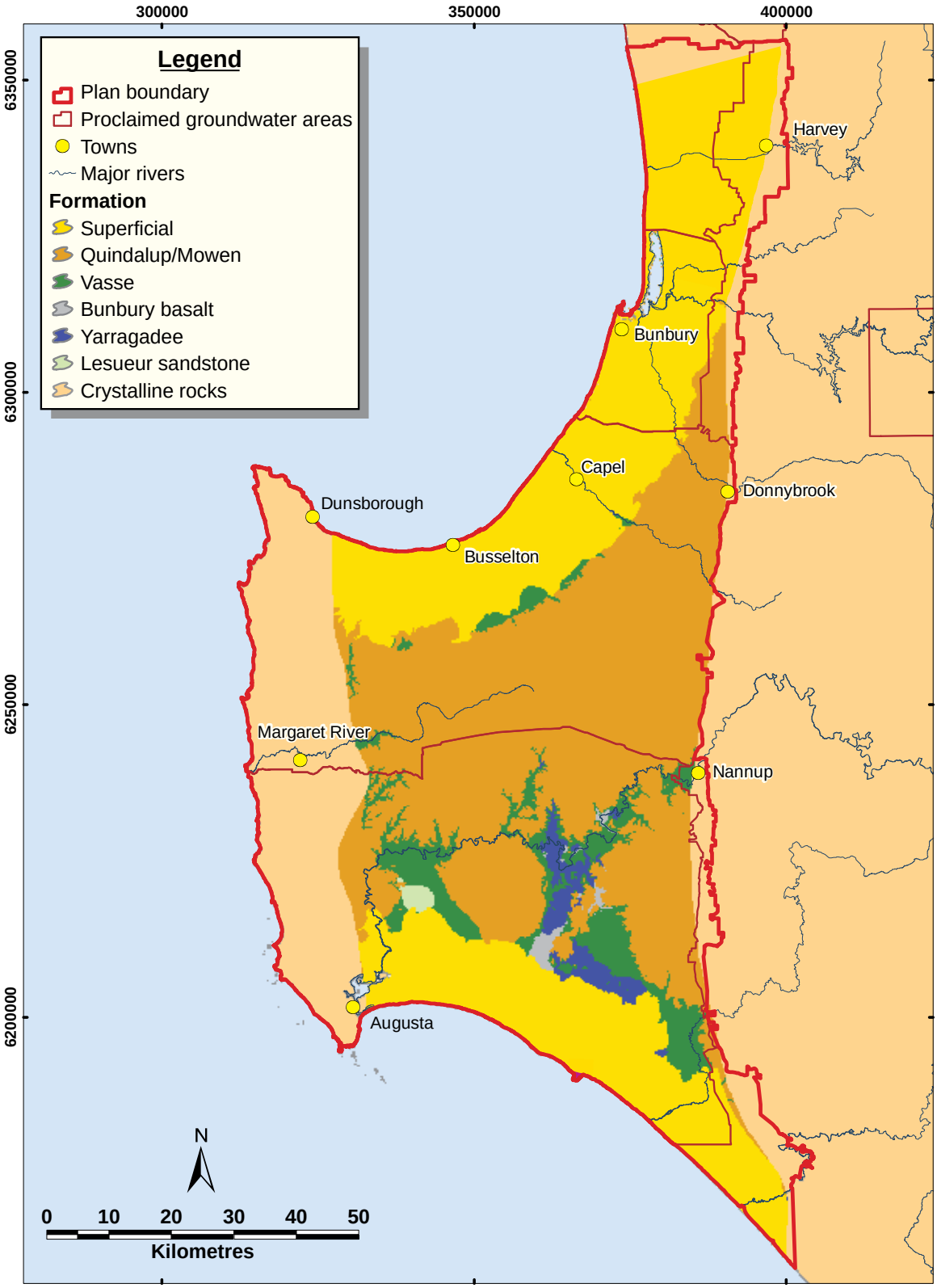


Figure 2
Conceptual geological cross-section (west to east) of the Southern Perth Basin



Locality map

Government of Western Australia
Department of Water

This map is a product of the Dept of Water, Water Resource Use Division and was printed on 13/02/2009.

While the department has made all reasonable efforts to ensure the accuracy of this data, the department accepts no responsibility for any inaccuracies and persons relying on this data do so at their own risk.

Sources

DoW acknowledges the following datasets and their Custodians in the production of this map:

Western Australia Towns – DLI – 2003
Global Map Data Australia 1M – GA – 30/06/2001
Plan_Boundary – DoW – 05/11/2007
Hydrography, Linear (Hierarchy) – DoW – 08/06/2006
Aquifer modelling software – DoW – 08/2006
RIWI Act, Groundwater Areas – DoW – 06/03/2008

Datum & projection information

Vertical datum: AHD
Horizontal datum:GDA 94
Projection: MGA 94 Zone 50

Project information

Requestee: Rebecca Palandri
Map Author: Brenden Huntley
Filename J:\pp\wa\C2106\0007\mxd\090130_SWGA_water table aquifers.mxd
Date: 30/01/2009

Figure 3
Surface hydrogeology of the plan area

Major aquifers

The major aquifers (ordered from shallow to deep) are the Superficial (and Surficial), Leederville and Yarragadee aquifers.

Superficial and Surficial aquifers

The Superficial Aquifer within the plan area is the watertable aquifer on the coastal plains (Figure A5). The sediments on the Swan and Scott coastal plains are collectively termed the Superficial formations and comprise the Superficial Aquifer. The Superficial formations are the Yoganup, Guildford, Bassendean Sand, Tamala Limestone and Safety Bay Sand formations. The Superficial Aquifer is separated in places from the underlying Leederville Aquifer by a confining layer called the Mowen aquitard.

Apart from the coastal dunes, the formations are generally less than 10 m thick (saturated thickness), and are only a few metres thick on the western part of the coastal plains. Bore yields in the Superficial Aquifer on the coastal plains are highly variable and depend on sediment type (for example, clay will typically yield less water than saturated sands). The general trend in water levels on the coastal plains is declining summer minimum levels with steady winter maximum levels after the Superficial Aquifer is recharged by rainfall.

Limited and seasonally available quantities of unconfined groundwater may be available from saturated surficial sediments (Surficial Aquifer) comprising aeolian, colluvial and alluvial sandy sediments. The occurrence of the surficial aquifer will be localised, including perched groundwater above impermeable beds of the Leederville and Yarragadee formations, weathered bed rock (Bunbury Basalt and Leeuwin–Naturaliste Ridge) and local confinement zones of low permeability in the laterite profile. The surficial aquifer is recharged predominantly by local rainfall and surface drainage. Limited supplies of groundwater are present within surficial aquifers formed within saturated Quaternary aeolian sand and, to a lesser extent, alluvial palaeochannel sediments. Groundwater quality is highly variable from fresh to saline depending upon location and proximity to surface water features. Groundwater yields are commonly low.

Leederville Aquifer

The Leederville Aquifer is a confined aquifer that underlies the Superficial formations on the coastal plains, and occurs, in places, at the surface on the Blackwood Plateau, where it is weathered and lateritised. The Mowen aquitard consists of the Quindalup and Mowen members where they are dominated by clay and silty clay units. Where the Quindalup Member is dominated by sand, and the Mowen Member thins, there is a coincident increase in sand content. As a result, these members effectively become part of the Leederville Aquifer (Figure A1) (Water Corporation 2005b).

This aquifer is typically about 100 m thick, reaching over 200 m in places. The Leederville Aquifer is the most widely used aquifer on the Swan coastal plain, as it is relatively shallow, contains generally fresh groundwater, and is higher yielding than the Superficial Aquifer.

The current trend across the plan area in the Leederville Aquifer is a slow decline of up to 1 to 2 m in summer water levels over 20 years and a slow decline in winter levels. It should be noted that a large portion of this decline has been over the last five years (2003–08) corresponding to a low rainfall period, and may also be due to higher levels of pumping. In some areas more pronounced declines are apparent such as around the Jindong agricultural area. A seawater interface is close to, or is intersecting the coast between Dunsborough and Bunbury.

Yarragadee Aquifer

The Yarragadee Aquifer is a mostly confined aquifer composed of the Yarragadee Formation, basal units of the overlying Parmelia Formation and parts of the underlying Cockleshell Gully and Lesueur Sandstone formations. The Yarragadee Aquifer is unconfined where it outcrops in areas on the Blackwood Plateau and subcrops beneath the Superficial Aquifer on the coastal plains. The Yarragadee Aquifer is

confined where it is separated from the overlying Leederville Formation by the discontinuous aquitards formed by the Bunbury Basalt and shale units of the Parmelia Formation.

The Yarragadee Aquifer is a regionally confined aquifer, meaning that abstraction from any location may have an impact on the pressure of water at discharge points (such as at the Blackwood River). It is the largest aquifer system of the plan area, occurring throughout the Bunbury Trough and contains mostly fresh groundwater. The aquifer thickness ranges from about 300 to 1700 m within the Bunbury Trough through the main part of the aquifer, and is shallowest (approximately 15 m below surface) south of Bunbury and in several places on the Blackwood Plateau (recharge area).

The Yarragadee Aquifer is made up of several sub-units, each with distinct lithological and hydraulic properties. The main component of the Yarragadee Aquifer is the predominantly sandy Unit 3 which has a maximum thickness of about 800 m (Figures A2–A4) (Water Corporation 2005b).

Bores in this aquifer are capable of large yields of up to 6000 to 20 000 kL/day. Groundwater level trends for the Yarragadee Aquifer show declines of up to two metres over the last 10 years. A seawater interface in this aquifer intersects the coastline at Bunbury.

Other aquifers

There are a number of minor aquifers which occur at varying depths in relation to the major aquifers. They include the Cattamarra Coal Measures, Lesueur Sandstone, Sue Coal Measures and the fractured rock aquifer.

Cattamarra Coal Measures

The Cattamarra Coal Measures is one of two formations that comprise the Cockleshell Gully Formation. The Cattamarra Coal Measures are a regionally confined multi-layered aquifer composed of siltstone and shale interbedded with sandstone. The groundwater salinity ranges between 250 and 26 000 mg/L TDS and in general, the groundwater salinity is lower in the south than in the north. The fresher quality groundwater in the southern part of the aquifer is likely to be attributed to the throughflow from the Yarragadee Aquifer. In the area of the Kemerton Industrial Park, the salinity is mostly brackish. The depth and the salinity of this aquifer restrict its utilisation for consumptive use and the measurement of water levels shows they are steady.

Lesueur Sandstone Aquifer

The Lesueur Sandstone Aquifer incorporates the Lesueur Sandstone and Sabina Sandstone formations. The aquifer occurs throughout most of the southern Perth Basin except for the northern Vasse Shelf and in the southern part of the shelf just east of Augusta (Water Corporation 2005b). The aquifer is only exploited for groundwater on the Vasse Shelf where it is overlain by the Leederville or Superficial formations. It outcrops east of Alexander Bridge on Brockman Highway and possibly near the Scott River. To find out more about the hydrogeology of the Lesueur Aquifer drilling investigations will be completed in 2009 or 2010.

Sue Coal Measures

The Sue Coal Measures is the lowermost unit in the Southern Perth Basin, overlying basement rock (Water Corporation 2005b). It is deeply buried within the Bunbury Trough and occurs below the Leederville or Superficial formations on the Vasse Shelf, with no outcrop at ground level. The formation has a maximum known thickness of approximately 1800 m in the Vasse Shelf and is intensely faulted. The sandstone is consolidated and partially cemented, and typically has a low permeability. Thin, coarser, less cemented layers may be present locally. The ability to abstract water from this aquifer is variable due to its hydrogeological characteristics. Existing (but limited) measured data shows the water levels are generally steady in this aquifer.

Box 3: Modelling groundwater

The South West aquifer modelling system version 2 SWAMS v 2 (Water Corporation and Department of Water) was used to predict the potential localised and regional drawdown effects of groundwater abstraction and to formulate a three-dimensional water balance. Abstraction of groundwater was accounted for by including current groundwater licences and predicted future town water supply abstractions in the model. The resulting watertable drawdown map was used to quantitatively assess the risk to representative groundwater-dependent ecosystems.

The three-dimensional water balance for each aquifer was used to quantify the available water for each aquifer within each subarea. The water balance used in the model is an equation which represents the amount of water entering (input) and leaving (output) a groundwater system. Inputs to the system include rainfall recharge, aquifer leakage (into other aquifers) and stream (surface water) leakage. The outputs include plant water use (transpiration), atmospheric evaporation, abstraction of groundwater, discharge to streams and flow through to the ocean.

The water balance equation is used to determine the sustainable yield of an aquifer which is used in defining the allocation limits (see Section 4.1). The sustainable yield is the volume of water that can be abstracted from an aquifer (from the inputs) while maintaining the throughflow within the aquifer, seawater interface and groundwater-dependent ecosystems (outputs) at an acceptable level of risk.

Fractured rock

The Leeuwin Complex is classified as a fractured rock aquifer, in which groundwater is restricted to fractures in the crystalline basement rocks (bedrock), and to a thin weathered zone and overlying surficial deposits. Caves and cavities are common in the Tamala Limestone which directly overlies the bedrock. Where the limestone occurs there is rapid drainage of surface waters, and the presence of underground streams. Depending on the bedrock topography the drainage is known to discharge into springs along the coast.

The nature of the fractured rock restricts the location and volume of water that can be abstracted. The water level information in this area does not lend itself to a generalised comment due to the fractured nature of the aquifer and the complexity in determining linkages between water levels, pumping and recharge.

Modelling groundwater

Box 3 gives a brief description of the South West aquifer modelling system (SWAMS) which was developed by the Department of Water and the Water Corporation. Further information on the model development, calibration, and use can be found in Aquaterra 2002, CyMod Systems 2004, Environmental Resource Management 2004, Sun 2005, Water Corporation 2005a and 2005b, and Varma 2009.

Water management and use implications

The understanding of groundwater in this region has been greatly improved through the investigation work carried out by the Department of Water and the Water Corporation. Due to the high cost (> $ 500 000 for each bore) of deep aquifer investigations our understanding remains at a regional scale, with local investigations only completed for a few areas. This level of uncertainty is accounted for in planning and licensing decisions.

Allocation limits are designed to manage the sustainable abstraction of the groundwater resources and recognise the uncertainty in aquifer understanding. The allocation limit is determined by the department as the safe portion of the recharge volume for each aquifer that can be used for abstraction without affecting dependent ecological and social or cultural systems (see Chapter 4).

When considering allocation limits for each aquifer we recognise that if too much water is taken out of the deeper aquifers, it may induce more leakage from the shallow aquifers above, leading to impacts on dependent systems at the surface. This is because there are often gaps in the confining layers where leakage between aquifers can occur. As can be the case with the Yarragadee Aquifer, these effects may occur tens of kilometres from where the water is abstracted.

Because of the uncertainty about the effects of abstraction and climate variability, it is important to implement an effective monitoring program to assess these effects. The monitoring program for the South West groundwater areas is discussed in Chapter 6.

Action 1 – Complete further drilling investigations into the hydrogeology of the South West groundwater areas and report by 2011, to reduce uncertainty in groundwater management decisions and form part of the review of this plan.

Action 2 – Complete an annual resource assessment report which summarises resource trends including water levels, quality, connected systems and GDE sites.

Action 3 – Update and review groundwater models including surface water interactions and updated climate predictions.

Recommendations for licence applicants

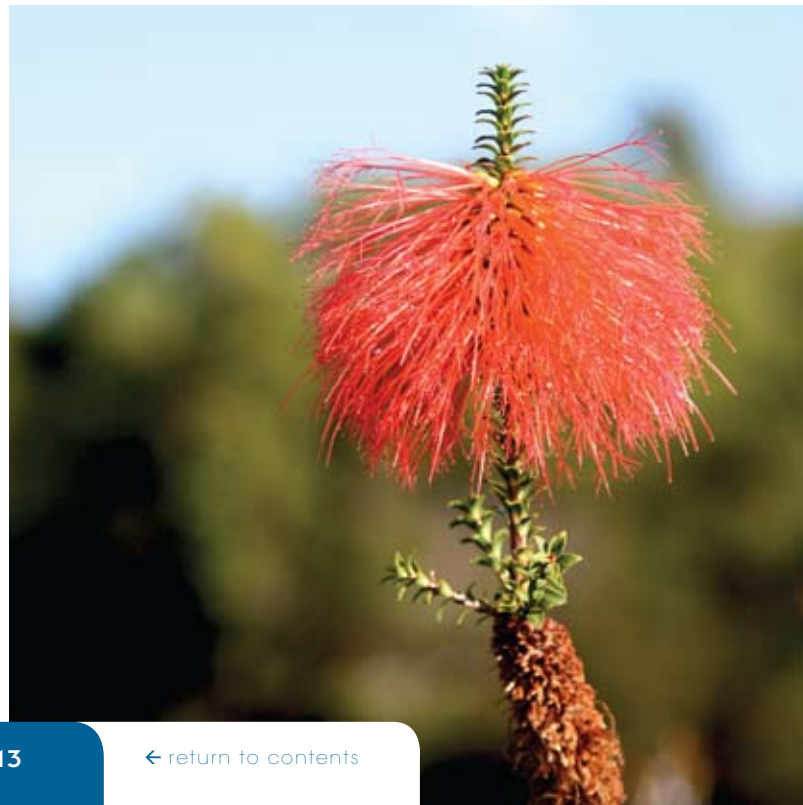
- When preparing to submit a licence application it is important to recognise the level of uncertainty in aquifer knowledge in your area and approach your decision-making appropriately.
- The taking of water from one aquifer may have impacts on other aquifers or other water users. Use of hydrogeological advice and/or groundwater modelling is recommended.
- Variability within aquifers means that the impact of taking water from one part of an aquifer may not be the same as in another part of that aquifer. The compounding effect of multiple abstractions on an aquifer should be considered when applying for a licence.
- When considering which aquifer to use it is important to understand that your water access is restricted by the aquifer's location and its characteristics, as while the water may be available for allocation, access may be restricted.
- Water yields and water quality vary between and within aquifers. It is important to consider whether the likely yields and water quality of the proposed source are appropriate for use. Understanding the source of your water is critical and discussions with the department will aid in your business planning.

2.2 Climate change

Winter rainfall in the South West has decreased since the mid 1970s by about 10 to 15% (IOCI 2002). It appears that this is due to a change in the rainfall regime with a pronounced decrease in autumn and early winter rains (IOCI 2002). This reduction in rainfall is likely to continue, with less recharge to aquifers and lower and less frequent stream flows (IOCI 2005).

Through climate modelling CSIRO (Hennessy et al. 2006) has predicted that between 1990 and 2030 the South West may experience a 5 to 11% decline in average rainfall based on low (0.54 ˚C by 2030) and high (1.24 ˚C by 2030) global warming scenarios. This predicted change has been used by the department in the SWAMS v 2 groundwater modelling scenarios (see Box 4).

Despite the uncertainties of climate change the department is satisfied that the best available scientific knowledge has been used to anticipate further decreases in rainfall in the plan area. Further, by using the predictive capability of the SWAMS v 2 groundwater model we have been able to estimate and account for these potential impacts when setting allocation limits.



Box 4: Modelling climate uncertainty

Calibration of a model is the process where parameters in the model are fine tuned to get the best possible match between modelled and real water level trends over a defined period.

The SWAMS v 2 model (transient mode) was calibrated over the period 1990 to 2003 using the average rainfall over this period, which was about 7 per cent lower than the long-term average. This corresponded to about 655 GL/yr of gross recharge (all aquifers).

For the modelling of future allocation scenarios (2003 to 2033), recharge was reduced further to account for rainfall over the period 1971 to 2003, which was about 9% lower than the long-term average (Strategen 2004, Varma 2009). This corresponded to about 620 GL/yr of gross recharge (all aquifers).

To account for future climate change recharge was reduced by an additional 5 per cent to 590 GL/yr (all aquifers) to represent the declines in annual rainfall predicted by the CSIRO (Hennessy et al. 2006).

Water management and use implications

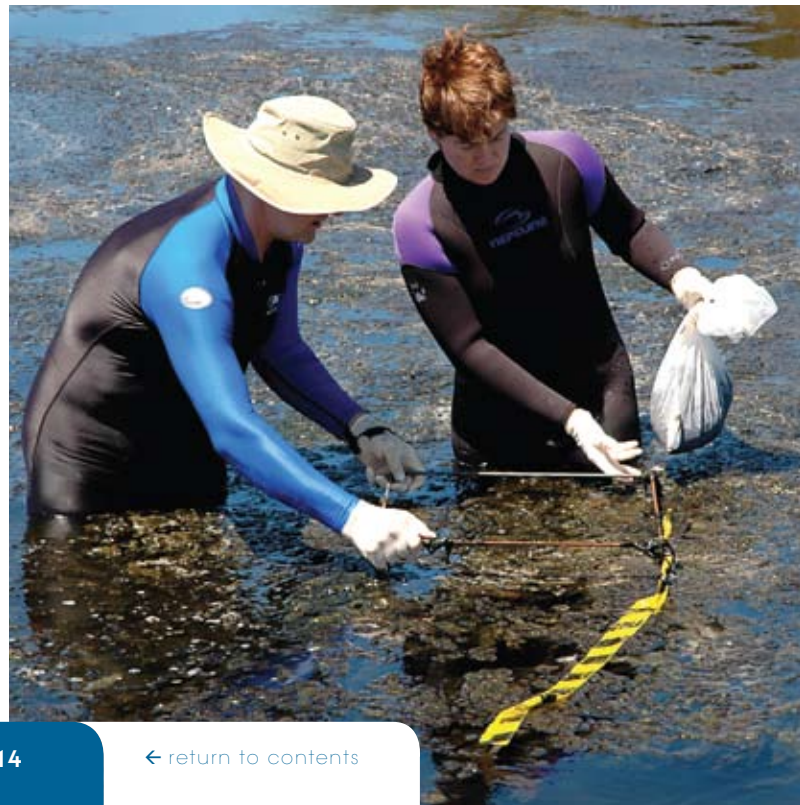
Accounting for climate change in management and planning is an on-going process for the department. The ability of SWAMS v 2 to determine recharge and shallow aquifer interaction will be improved with the new knowledge gained from the actions recommended by this plan. This will improve our assessment of climate change impacts and modelling predictions.

The knowledge gained from the actions recommended by this plan will also improve the department's ability to make predictions and decisions about acceptable hydrological regimes at important groundwater dependent ecosystems, set adaptable ecological water requirements that account for climate change and will assist in setting environmental water provisions for management plans. This includes investigating the groundwater dependence of South West vegetation communities and creating a conceptual model to predict how a vegetation community will react to different hydrological regimes, including climate change.

The reductions in rainfall that have already occurred together with the likelihood of further drying because of climate change have and will further reduce the water available for consumptive use in the South West groundwater areas. Climate change reinforces the importance of all users becoming more efficient in their use of water.

Recommendations for licence applicants

- Where we have determined that an application for a groundwater licence requires computer modelling to assess the impacts of a proposal you will be asked to include predicted declines in rainfall in the modelling scenarios.
- Drought contingency plans may be necessary for large applications, particularly for water service providers, with a variety of water sources needed to meet the required demand.
- If you are submitting a new proposal or renewing an existing licence, options to improve water use efficiency to maximise economic outcomes with limited water should be included in your application. Applications that are based on inefficient use of water will not be supported.



2.3 Groundwater quality

Groundwater salinity

In the confined aquifers, such as the Leederville and Yarragadee, groundwater is generally fresh, with minor areas of brackish water (see Table 5 for salinity thresholds). Salinity is generally lowest in the recharge areas, increasing along the groundwater flow path towards the coast. The salinity originates as salts in rainfall, concentrated through evaporation and evapotranspiration. The salinity tends to be low in transmissive sandy soils, and greatest in sediments of lower permeability. There is some interaction along the seawater interface near the coastline along the Swan coastal plain.

Watertable (generally Superficial Aquifer) groundwater can become saline through secondary salinity processes such as recirculation of irrigation water. Recirculation occurs where water is continually abstracted and re-applied from the same aquifer with evaporation, evapotranspiration and added salts from fertilisers increasing the salt content each time it is used. This concentrates the salt in the water and when it drains through the soil profile into the watertable and is used again the cycle continues. This has become an issue for the coastal plain north of Bunbury in the Lake Preston area.

Historically, water quality measurement of the department's regional monitoring bore network has occurred infrequently, so it is difficult to determine regional trends in water quality, including salinity. Currently a regional water quality measurement program is being developed and monitoring will be initiated as part of the implementation phase of this plan. See the *South West groundwater areas monitoring program* (DoW 2008g) report for more information on water quality measurement and monitoring.

Seawater interface

The seawater interface occurs where fresh groundwater meets and mixes with saline groundwater along the coast. Where freshwater is discharging as throughflow into the sea, the interface will be maintained offshore. If the freshwater throughflow is reduced by cumulative drawdown from abstraction wells or long term declines in rainfall, the seawater interface gradually moves inland. It is critical to maintain throughflow to the ocean from all aquifers, to ensure groundwater remains fresh for coastal users.

Maintaining discharge of fresh groundwater into the ocean may also be important for near-shore marine ecosystems. Hatton and Evans (1998) indicated that most estuarine or marine systems only use groundwater to a limited extent, though some have been known to show a response to changes in groundwater quality (Froend and Loomes 2005).

The seawater interface in the Superficial Aquifer on the Swan coastal plain usually occurs naturally as a wedge of seawater extending as much as one kilometre inland at the base of the aquifer, with fresh groundwater discharging to the seashore above it.

In the Leederville Aquifer, tongues of saline water are intersected at various depths along the coastline of Geographe Bay. This also occurs in the Yarragadee Aquifer, where saline groundwater has been found near the coast at Bunbury, where it directly underlies the Superficial Aquifer. At Busselton, where the natural potentiometric head in the Yarragadee Aquifer is 15 m above sea level, fresh groundwater is inferred to extend many kilometres offshore.

Acid sulfate soils

Acid sulfate soils (ASS) are naturally occurring soil sediments containing sulfide minerals, predominantly pyrite (an iron sulfide). Potential acid sulfate soils (PASS) are benign acid sulfate soils in an undisturbed state below the watertable. However, when these are oxidised by exposure to air or other oxidising agents, such as nitrate from fertiliser, the sulfides can react to form sulfuric acid. Exposure to air can occur when soils are drained, excavated or the watertable is lowered. Other complex secondary reactions can also occur, including mobilisation of metals. When potential acid sulfate soils have been disturbed and there is evidence of oxidation the soils become actual acid sulfate soils.

Disturbance of potential acid sulfate soils can cause the iron sulfides to oxidise. Disturbed PASS materials can result in contamination of shallow groundwater with high concentrations of dissolved iron and aluminium as well as other trace metals.

Work by the Department of Environment and Conservation (DEC) in coastal areas of the plan area indicate that much of the low-lying lands of the Swan and Scott coastal plains have areas containing PASS materials (Figure 4). There are several sites in the plan area that have exposed PASS materials resulting in acid sulfate soil generation, supporting this indication. The department will carefully assess any water use in these areas to aid the current management and avoid any further water quality impacts.

The Department of Environment and Conservation manages acid sulfate soils where impacts are identified and the sites are classified as contaminated under the *Contaminated Sites Act 2003*. For more information on acid sulfate soils please see the Department of Environment and Conservation's website: <www.dec.wa.gov.au/management-and-protection/acid-sulfate-soils/index.html>.

Water management and use implications

We recognise that abstracting groundwater will lower the water levels (potentiometric heads) in aquifers and reduce throughflow which may in turn cause inland movement of the seawater interface. Allocation limits are set to avoid these impacts where possible. In areas where the seawater interface is already moving inland, or exists naturally in an aquifer, allocation limits and policies are set to reduce or manage this impact. By limiting and managing abstraction in areas at risk, any increase in salt levels in existing bore users in coastal areas should be prevented.

In areas of known potential acid sulfate soil risk in the South West groundwater areas, we have accounted for possible cumulative drawdown effects of groundwater abstraction on the watertable when setting allocation limits. Licensing policies and conditions are set to manage groundwater abstraction and use in these areas to prevent mobilisation of acid sulfate soils.

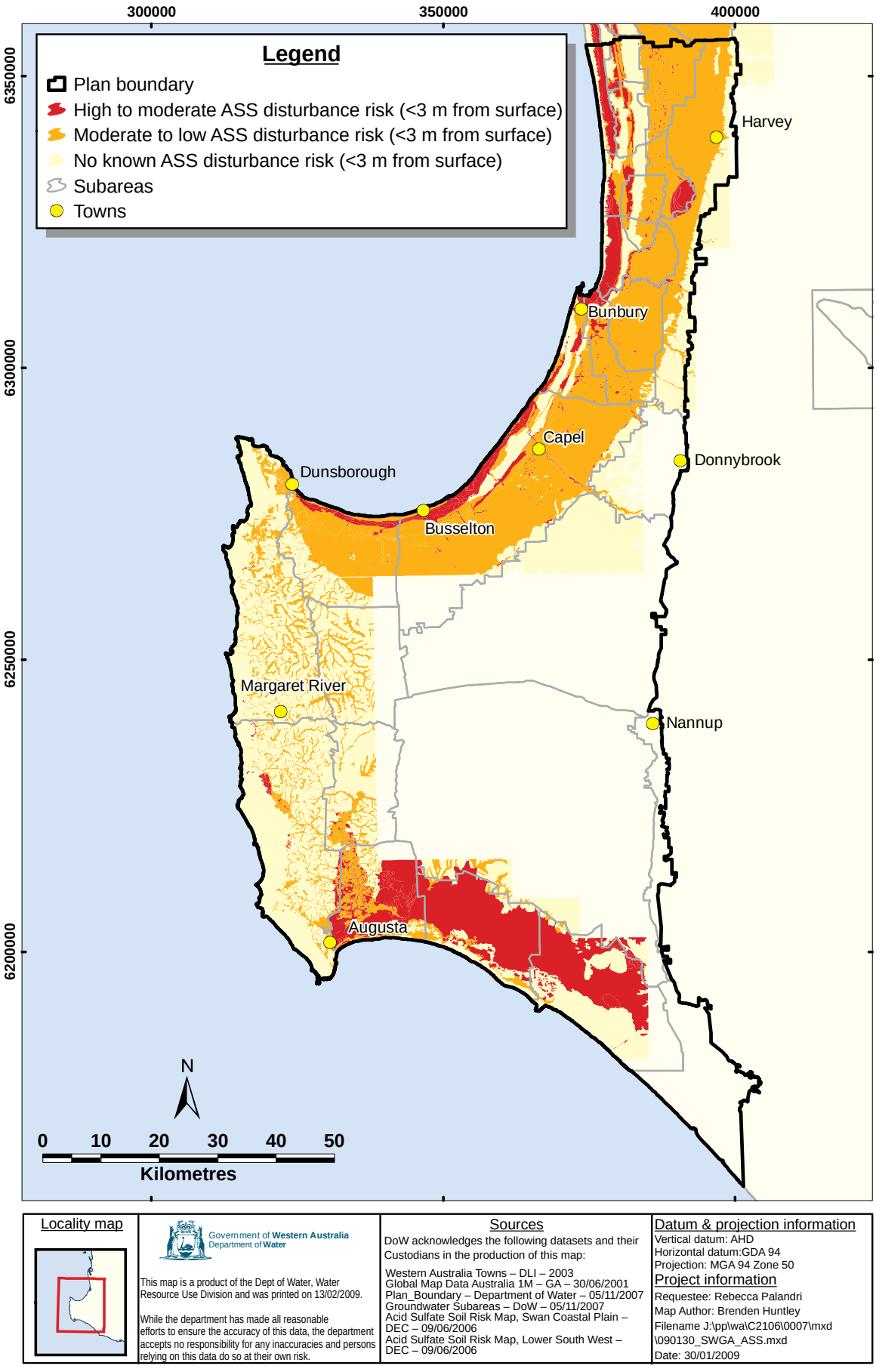
We will be working with other agencies to investigate the issue and management of acid sulfate soils to assist ongoing water management. We will also be working with other agencies to manage salt water recycling in areas where increasing salinity is an issue.

Action 4 – Implement the *South West groundwater areas monitoring program*.

Action 5 – Report on the current understanding of the buffering capacity of sediments with associated potential acid sulfate soil risk to inform the review of this plan and its associated monitoring program.

Recommendations for licence applicants

- It is important to note that in some areas we will restrict water application rates in areas at risk of increasing salinity due to salt recycling.
- When preparing to submit a licence application a water balance for irrigation should be undertaken to minimise the chance of salt recycling and the resulting damage to soil quality and reduction in crop yields.
- Concentration of water abstraction near the coast may result in localised movement of the seawater interface inland. If you plan on abstracting water in this area you may be asked to monitor water quality to make sure that your abstraction is not drawing the seawater interface further inland.
- If your licence application is identified as being in a high risk potential acid sulfate soil area it is essential that you liaise with the Department of Environment and Conservation regarding your obligations for minimising exposure of this material as a result of your water use.
- We will carefully assess licence applications in areas of high risk of potential acid sulfate soil and identified sites of acid sulfate soil exposure. You may be required to undertake monitoring as part of your licence conditions if your abstraction is in these areas.
- Dewatering for any period of time can cause exposure of potential acid sulfate material. If your proposal requires dewatering you will need to investigate whether the area contains these materials and demonstrate how mobilisation of acid sulfate soil will be avoided or potential impacts mitigated.



Locality map

Government of Western Australia
Department of Water

This map is a product of the Dept of Water, Water Resource Use Division and was printed on 13/02/2009.

While the department has made all reasonable efforts to ensure the accuracy of this data, the department accepts no responsibility for any inaccuracies and persons relying on this data do so at their own risk.

Sources

DoW acknowledges the following datasets and their Custodians in the production of this map:

Western Australia Towns – DLI – 2003
Global Map Data Australia 1M – GA – 30/06/2001
Plan_Boundary – Department of Water – 05/11/2007
Groundwater Subareas – DoW – 05/11/2007
Acid Sulfate Soil Risk Map, Swan Coastal Plain – DEC – 09/06/2006
Acid Sulfate Soil Risk Map, Lower South West – DEC – 09/06/2006

Datum & projection information

Vertical datum: AHD
Horizontal datum:GDA 94
Projection: MGA 94 Zone 50

Project information

Requestee: Rebecca Palandri
Map Author: Brenden Huntley
Filename J:\pp\wa\C2106\0007\mxd\090130_SWGA_ASS.mxd
Date: 30/01/2009

Figure 4
Location of potential acid sulfate soil risk areas

2.4 Hydrology

There are important surface water resources in the South West. The seasonal variability in these systems is generally influenced more by rainfall and changes in rainfall patterns than by groundwater. However, groundwater can play a vital role in a waterway, particularly over the summer period. The surface water hydrology and its management in the area of this plan are covered by the *Whicher area surface water allocation plan* (DoW 2009a).

Groundwater and surface water connectivity

In the South West groundwater area there are surface water features such as lakes and rivers that are strongly connected to, and are dependent on, groundwater. These include internationally and nationally important wetlands, such as Lake Jasper. These features are known as connected systems. A recent study by the department of river systems and larger permanent wetland systems identified several connected systems in the plan area (Figure 5) (DoW 2008g). This study also discusses the monitoring and investigations the department has instigated to integrate the management of connected groundwater and surface water resources (DoW 2008g) (Figure 5).

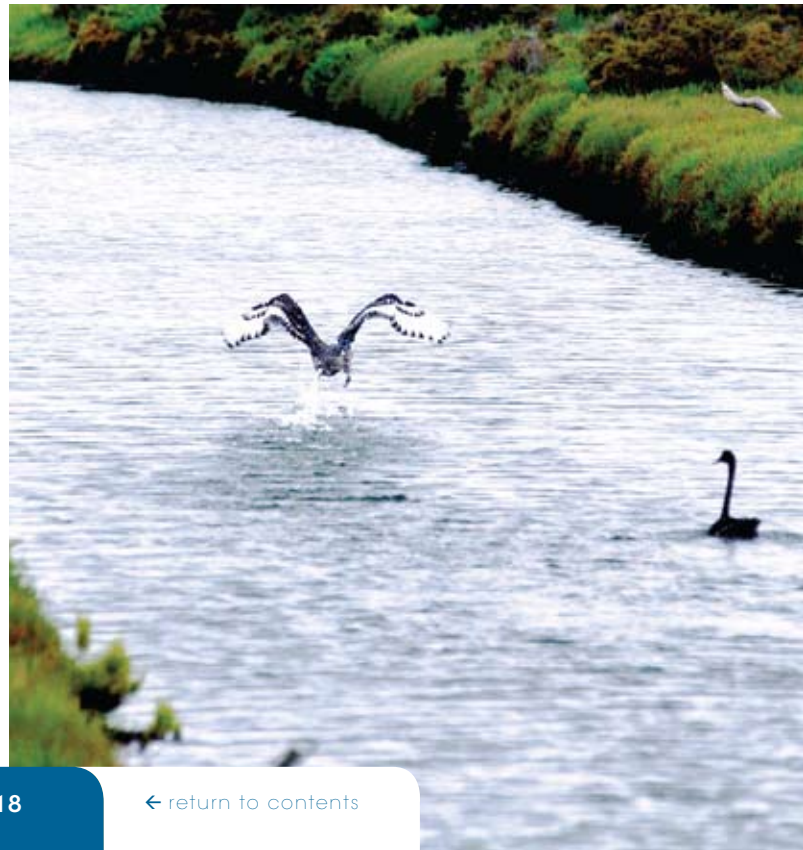
An example of this interconnection between groundwater and surface water is the Yarragadee Aquifer discharging to the Blackwood River and its tributaries Milyeannup Brook and Poison Gully. The discharge maintains perennial flow and important environmental values in the tributaries and permanent pools in the river. Another example is the Leederville Aquifer discharging into the lower Blackwood River between Nannup and Milyeannup Brook and downstream of Layman Brook, supplying base flow to the river, improving water quality, and maintaining permanent pools throughout the summer months. St John and Rosa brooks, and upper Margaret River are Leederville dependent. Many rivers on the coastal plains, such as the Scott and Capel rivers, are also supported by groundwater (Figure 5).

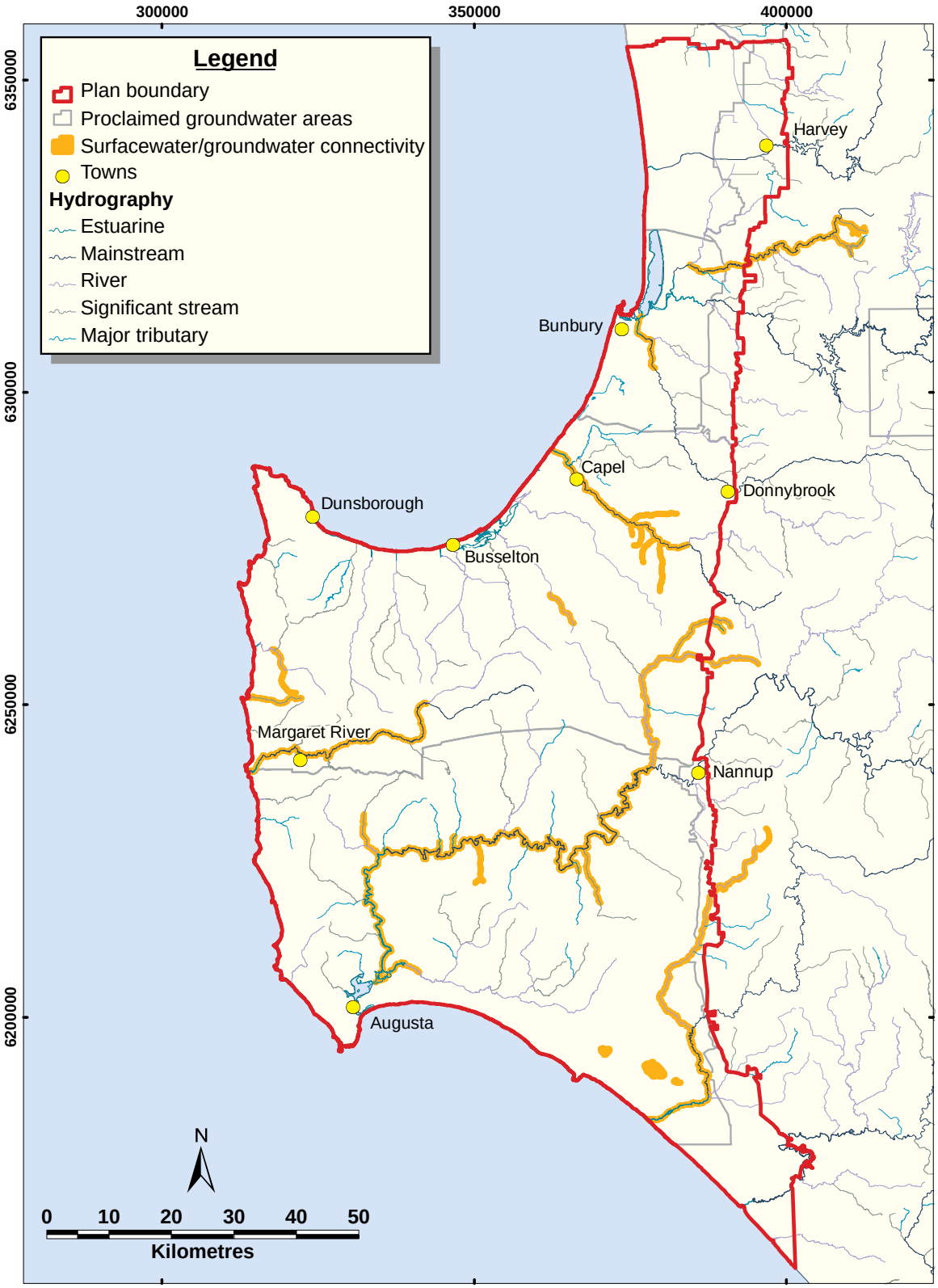
Water management and use implications

To ensure consistency with other department water allocation plans, the allocation limits and licensing policies in this plan take into consideration the connected systems and support the *Whicher area surface water allocation plan*.

Recommendations for licence applicants

- When applying for a licence always consider the Whicher area surface water allocation plan alongside this plan as a new (or an increase to an existing) groundwater licence application may affect surface water systems.
- If groundwater is not available you can consider using surface water as an alternative water source.
- If you are going to dig an excavation as part of a dam construction it is likely that it will intersect the watertable. This will fill part of the dam and may require a groundwater licence, as this is part of the water being pumped.





Locality map

Government of Western Australia
Department of Water

This map is a product of the Dept of Water, Water Resource Use Division and was printed on 13/02/2009.

While the department has made all reasonable efforts to ensure the accuracy of this data, the department accepts no responsibility for any inaccuracies and persons relying on this data do so at their own risk.

Sources

DoW acknowledges the following datasets and their Custodians in the production of this map:

Western Australia Towns – DLI – 2003
Global Map Data Australia 1M – GA – 30/06/2001
Plan_Boundary – DoW – 05/11/2007
Hydrography, Linear (Hierarchy) – DoW – 08/06/2006
RIWI Act, Groundwater Areas – DoW – 06/03/2008

Datum & projection information

Vertical datum: AHD
Horizontal datum:GDA 94
Projection: MGA 94 Zone 50

Project information

Requestee: Rebecca Palandri
Map Author: Brenden Huntley
Filename J:\pp\wa\C2106\0007\mxd\090130_SWGA_SW_GW connection.mxd
Date: 30/01/2009

Figure 5
Known areas of connectivity between surface and groundwater

2.5 Groundwater-dependent ecosystems

Within the plan area there are several internationally important wetlands and a number of nationally and state recognised ecosystems (Hyde 2006). The natural environment is appreciated by the many people who live in or visit the area. The need to conserve this environment has been stated repeatedly in almost all community consultation that has been conducted as part of this planning process.

All ecosystems depend on water for their existence. However, not all ecosystems depend primarily on groundwater as the source of that water. While the number and the geographic spread of groundwater-dependent ecosystems in the South West groundwater areas is very large (Figure 6), the level of groundwater dependence and the environmental importance of the ecosystems vary greatly. Depending on the nature of the geological formation on which they lie, some groundwater-dependent ecosystems may only be affected by local changes in water regimes, while others may be affected by changes within aquifers at great depth and many kilometres away.

The South West groundwater areas cover a large area of complex hydrogeology. In the South West there are three aquifers that supply most groundwater users – the Superficial, Leederville and Yarragadee aquifers. Declining rainfall affects each of these aquifers and drainage and land-use activities affect the Superficial Aquifer further. All of these aquifers support groundwater-dependent ecosystems.

In the Superficial Aquifer, abstraction, drainage and the pattern of rainfall may affect groundwater-dependent ecosystems. The level of these impacts will be dependent on the magnitude of change and the proximity to the dependent ecosystems. Many wetlands of recognised (legislated) significance exist in these areas.

The heterogeneity and less permeable nature of clay lenses within the Leederville Aquifer offers some protection to groundwater-dependent ecosystems from groundwater level changes by muting the transmission of impacts through the aquifer. However, in some areas, dependent ecosystems may still be affected by Leederville Aquifer abstraction or reductions in recharge from climate change. Groundwater-dependent ecosystems on the Swan coastal plain, upper Margaret River, St John Brook and Reedia wetlands are examples of such systems (Figure 7 and 8).

In most areas impacts on groundwater-dependent ecosystems from water level changes within the Yarragadee Aquifer are prevented or inhibited by other less permeable aquifers, aquitards or aquicludes that lie between it and the ecosystems on the land surface.

Exceptions to this are:

- part of the Blackwood River valley, where the Yarragadee Aquifer is close to the surface and directly supports wetland and river systems
- parts of the Swan and Scott coastal plains, where the aquifers that lie above the Yarragadee Aquifer do not present an effective barrier for preventing changes from being transferred to the watertable at the surface.

These areas are more at risk from the combined effects of groundwater abstraction and reduced rainfall and consequently have been the focus of recent investigations to determine the ecological values and ecological water requirements.

Representative groundwater-dependent ecosystem sites

Wetlands of high conservation value and areas of terrestrial vegetation were chosen as representative sites by a selection process that used wetland and vegetation mapping information together with an analysis of aerial photography, site visits and literature reviews. The representative sites are shown in Figure 7 and 8.

Generic ecological water requirements in the form of maximum drawdown and rate of change criteria were established at each reference site. Site-specific work was done at approximately thirty representative sites with the aim of developing a more detailed understanding of the water requirements. At some of these sites a management trigger and response framework has been applied (Appendix B) and this work is continuing so that the frameworks can be expanded to other sites when enough measurement data has been collected.

A summary of the investigations that have been carried out by the department can be found in Hyde 2006, Del Borrello 2008 and other documents listed in the bibliography.

Water management and use implications

The department considers the ecological values that are dependent on groundwater when making decisions on the allocation and management of groundwater resources. Although there are many sites of significant value, not all are groundwater dependent. The department has recognised this and aims to monitor the selected representative sites (Figure 7 and 8) to ensure that most of the dependent ecosystems, including the ones identified to be most at risk from abstraction or climate change, are managed, without unacceptable loss of values due to drawdown.

Effective monitoring is necessary to ensure that policy and allocation management decisions are effective in protecting critical environmental assets. The level of community interest in this aspect of water management is high and there will be public reporting of environmental monitoring and management outcomes by the department in the annual evaluation statement.

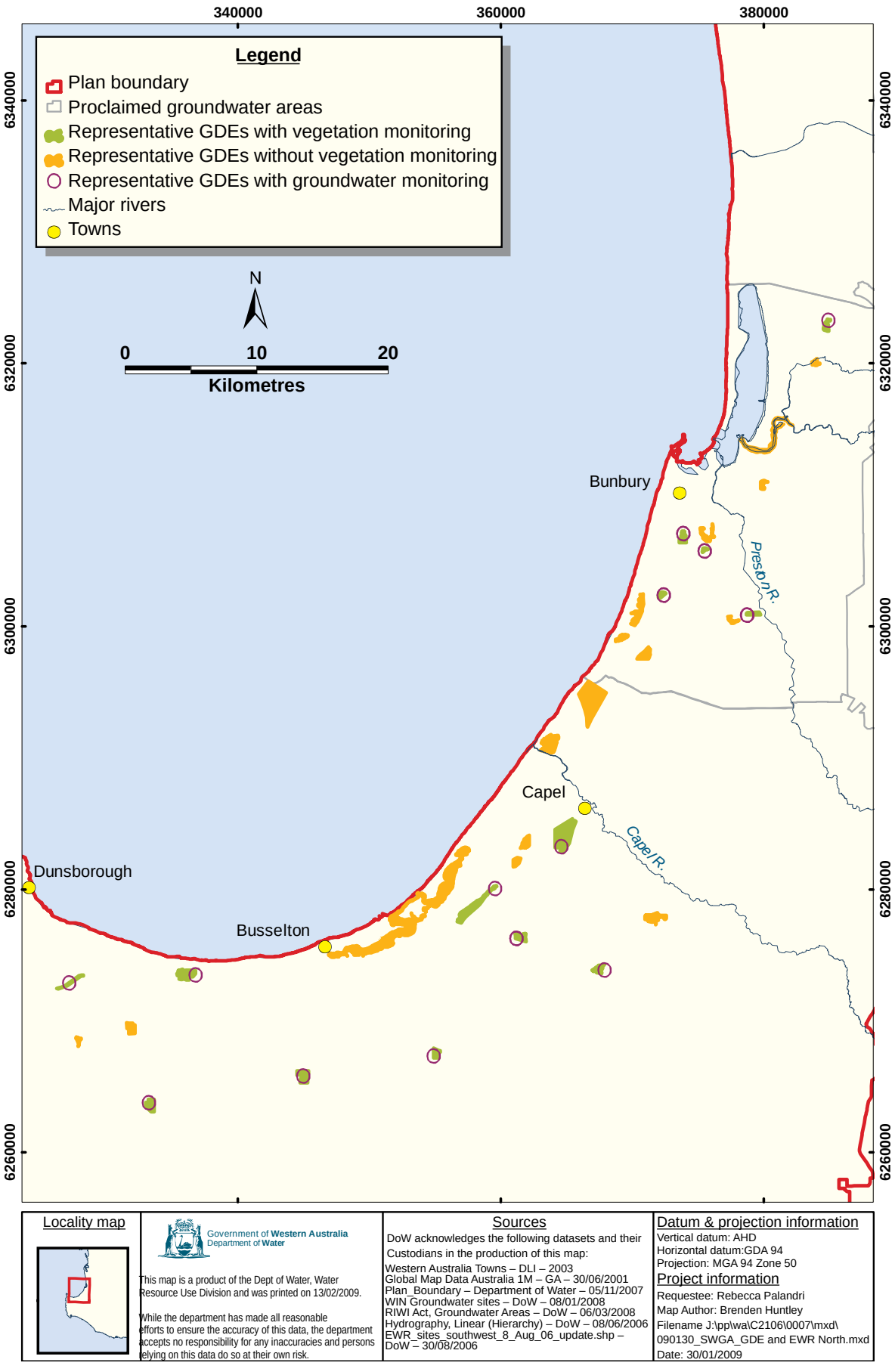
The department recognises that further reductions in rainfall are predicted for this area and that this, as well as potential pumping effects, are likely to have a significant impact on the water supply to ecosystems. This has been factored into the allocation decision-making process and is accounted for in all of the modelling underpinning this plan.

Action 6 – Conduct investigations into the most important groundwater-dependent ecosystem sites for aquifer connectivity and response to abstraction and climate change.

Recommendations for licence applicants

- While Figure 6 indicates the priority areas for groundwater-dependent systems, you should note that there are many others that have ecological values that will be considered in assessing your licence application. Where the watertable occurs within 10 m of the surface, native vegetation in such areas is likely to rely on groundwater to some degree. In general, the shallower the watertable, the greater the level of dependence. We will also consider other impacts on possible groundwater-dependent ecosystems (such as rainfall reduction and drainage) in licence assessments, as well as the effects of pumping.
- It is important to:
  - recognise that while your licence may not affect these sites, cumulative abstraction may lead to impacts and that groundwater modelling may be required to account for these impacts
  - recognise that there may be impacts associated with the connectivity between aquifers and that abstraction in one aquifer may affect another with potential flow-on effects to groundwater-dependent ecosystems
  - identify the location of possible groundwater-dependent ecosystems in relation to your proposed abstraction points and consider carefully the position and depth of your bores and the rate of abstraction to minimise the impact on environmental features
- A proposed application which may affect a groundwater-dependent ecosystem is likely to have monitoring conditions (or an operating strategy) associated with the licence that will include triggers and responses. These will be in line with the framework developed in Appendix B.

Figure 6
Potentially groundwater-dependent systems with recognised environmental, social and/or cultural value



Locality map

Government of Western Australia
Department of Water

This map is a product of the Dept of Water, Water Resource Use Division and was printed on 13/02/2009.

While the department has made all reasonable efforts to ensure the accuracy of this data, the department accepts no responsibility for any inaccuracies and persons relying on this data do so at their own risk.

Sources

DoW acknowledges the following datasets and their Custodians in the production of this map:

Western Australia Towns – DLI – 2003
Global Map Data Australia 1M – GA – 30/06/2001
Plan_Boundary – Department of Water – 05/11/2007
WIN Groundwater sites – DoW – 08/01/2008
RIWI Act, Groundwater Areas – DoW – 06/03/2008
Hydrography, Linear (Hierarchy) – DoW – 08/06/2006
EWR_sites_southwest_8_Aug_06_update.shp – DoW – 30/08/2006

Datum & projection information

Vertical datum: AHD
Horizontal datum:GDA 94
Projection: MGA 94 Zone 50

Project information

Requestee: Rebecca Palandri
Map Author: Brenden Huntley
Filename J:\pp\wa\C2106\0007\mxd\090130_SWGA_GDE and EWR North.mxd
Date: 30/01/2009

Figure 7
Location of representative groundwater-dependent ecosystems (Myalup to Dunsborough)

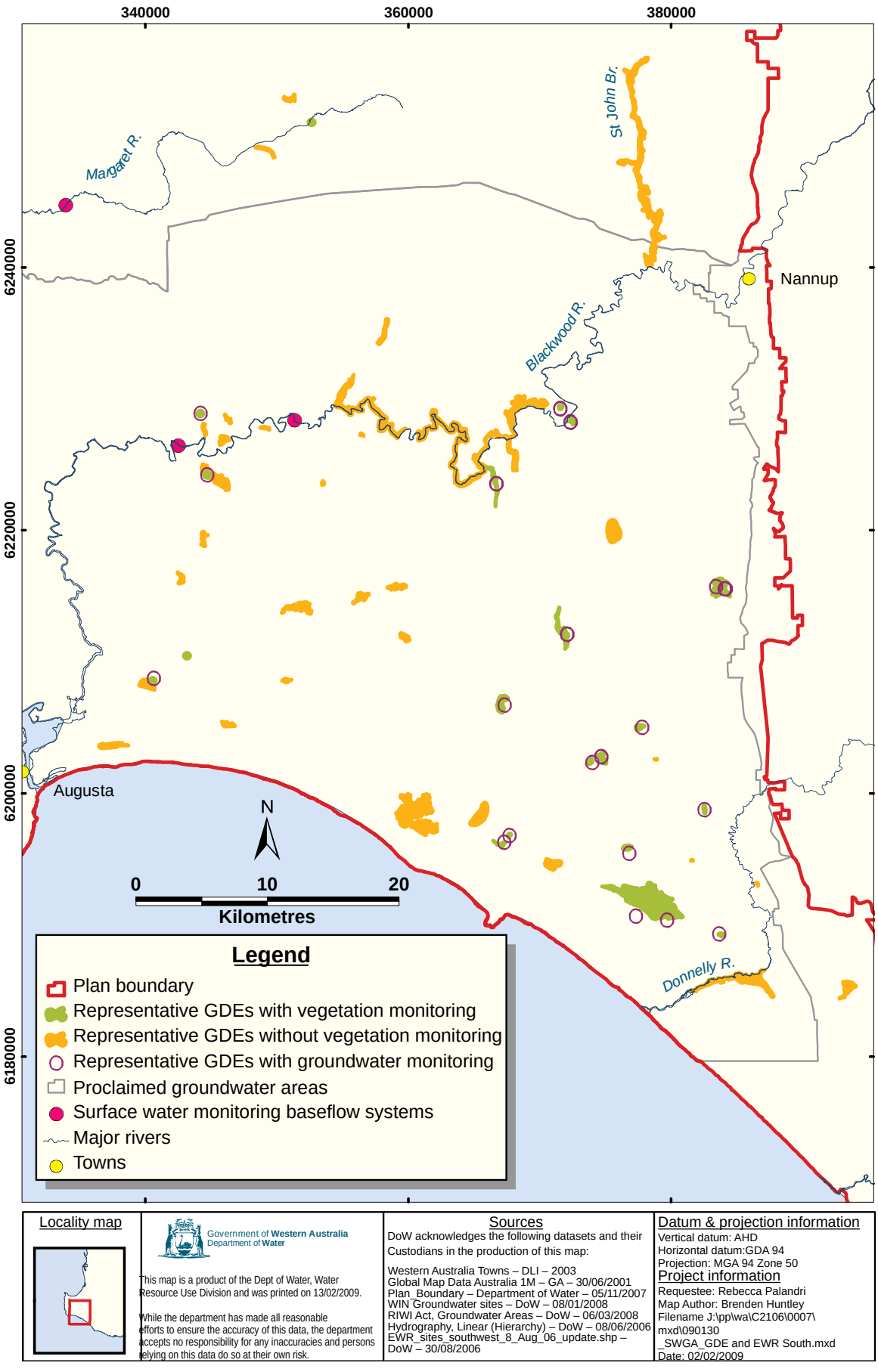


Figure 8
Location of representative groundwater-dependent ecosystems (Blackwood Plateau and Scott coastal plain)

2.6 Groundwater-dependent cultural and social values

The in situ cultural and social values relate to water found in its natural place. They are non-consumptive values which have been identified by assessing future water demand and community consultation.

The in situ social values that have been considered include, but are not limited to:

- recreational and tourism pursuits such as day use, camping, swimming, paddle sports, recreational fishing
- landscape and aesthetic values such as sense of wilderness and observing nature
- educational and scientific values
- Aboriginal cultural values (see Box 5)
- heritage values.

Through allocation planning, the department tries to identify the places where social and cultural values are linked to groundwater, and account for them. This accounting is referred to as a social water requirement. The social water requirement is often defined as a water level or water regime that needs to be met to protect the social and cultural values at a particular location.

Apart from some areas identified during the Yarragadee proposal process, the majority of cultural and social values were considered to be satisfied by meeting the ecological water requirements. That is, by providing a water regime to maintain the ecological values at a low level of risk, the social and cultural values are also protected.

To date the department has focused its efforts to determine social water requirements on the Blackwood River and tributaries below Nannup and Lake Jasper and the eastern Scott coastal plain area. We concentrated on these areas because of their high ecological, cultural and social values and because of their potential to be impacted by Yarragadee Aquifer abstraction in particular.

The Blackwood River cuts through areas where the Yarragadee Aquifer is exposed at the land surface. The Yarragadee Aquifer is present across most of the South West groundwater areas but it is generally deep and overlain by other formations. Reductions in water levels within the aquifer therefore become most apparent at the surface in such areas where the aquifer is shallow or overlain by the discontinuous Surficial aquifer (the lower Blackwood River, parts of the eastern Scott coastal plain and a small area around the City of Bunbury). Therefore, these areas are particularly susceptible to the effects of Yarragadee abstraction.

Areas of the Scott coastal plain, especially Lake Jasper, are very important to the Nyungar people and have high ecological and social values. A large proportion of the land area is remnant vegetation vested as national parks and nature reserves. Social and cultural values co-exist with economic development primarily in the form of irrigated agriculture.

Identified groundwater-dependent social and cultural values are protected by similar processes as the ecological values — via allocation limits, licence assessments, licence conditions and by monitoring and review. Continued investigation and planning work will help to improve our understanding of these values and their management.

Box 5: Aboriginal heritage and cultural values

The Aboriginal people of the South West are collectively known as the Nyungar people. The Nyungar people have a strong association with the environment and its natural resources, using it according to their lore and caring for Country. For the Nyungar people, Country is physically, spiritually, economically and culturally essential for survival, (SWCC 2005).

Understanding and respecting Aboriginal heritage and cultural values as they relate to water is an integral component of our work. We commissioned two studies in the Blackwood groundwater area (Goode 2003; Goode and Irvine 2006) to explore Aboriginal cultural values and determine the water requirements to support these values.

These reports discussed Aboriginal heritage as defined under the relevant legislation and also tried to identify the underlying Aboriginal social and cultural values of the region's water sources and their significance to the maintenance of Aboriginal culture and lifestyles.

Aboriginal heritage sites are sites of significance to Aboriginal people. The sites are listed on the Aboriginal Site Register which is held under Section 38 of the state's *Aboriginal Heritage Act 1972*. In the South West these sites tend to be located near various water sources, such as rivers, creeks, lakes, swamps and estuaries, confirming the importance of these waterways as areas favourable for camp sites and resource exploitation (O'Connor et al. 1995; Goode 2003).

The department recognises that Aboriginal cultural values extend beyond the Site Register and reflect their strong spiritual connection with the environment. The ability to teach future generations from a natural homeland is at the heart of the Aboriginal community's desire to maintain the ecological integrity of areas that may be affected by groundwater abstraction (Goode and Irvine 2006).

Water management and use implications

The department considers cultural and social values that are dependent on groundwater when making decisions on the allocation and management of groundwater resources. This consideration is formalised through our *Statewide policy no. 5 – Environmental water provisions policy for Western Australia,* (WRC 2000a). The department recognises that detailed work is required to identify social and cultural water requirements. The actions recommended in this plan aim to achieve a more considered approach in managing these requirements.

For a description of the processes used to determine the cultural and social values in the plan area and some of the challenges of determining social water requirements refer to Goode and Irvine 2006 and Goodreid 2007 or see the bibliography for more references.

Action 7 – Further define the groundwater-dependent cultural and social values to inform the review of this plan.

Action 8 – Create a GIS-based decision support tool that identifies groundwater dependent features and their associated cultural and social values to assist ongoing management.

Action 9 – Determine water requirements for groundwater-dependent cultural and social values to inform the review of this plan.

Recommendations for licence applicants

- It is important to recognise that social and cultural values may be dependent on groundwater and any associated impacts resulting from your abstraction will be considered in licence assessments.
- Native Title rights are considered as part of the assessment of a licence.
- It is your responsibility to contact the Department of Indigenous Affairs and undertake the appropriate action if your application has the potential to affect an Aboriginal heritage site. You must follow the appropriate processes under the *Aboriginal Heritage Act 1972* (WA) and the *Native Title (State Provisions) Act 1999* (Cwlth) before we can complete your licence assessment.

2.7 Existing use of groundwater

Over 150 GL/yr of groundwater is already used in the plan area for licensed commercial and water supply operations, as well as small scale domestic and stock use from the watertable aquifer, which is exempt from licensing. For more local detail on water use by aquifer and subarea please see the subarea reference sheets (DoW 2009c, d and e).

Across the plan area, from all aquifers, public water supply accounts for 24% of the total licensed entitlements. Horticulture (27%), pasture production (14%) and mining (14%) make up the bulk of the remaining licensed entitlements (Department of Water's licensing database, 2008). The major water use sectors licensed to obtain water from the Yarragadee Aquifer are public water supply (38%), mining (19%), horticulture (18%) and pasture production (15%). The major water use sectors licensed to obtain water from the Leederville Aquifer are horticulture (23%), public water supply (20%), and pasture production (16%).

Land use in the plan area is mostly state forest (Figure 9) which limits access to groundwater. Water use in these areas is restricted to small patches of cleared private land, public water supply and emergency use for fire fighting. The coastal plains and the Leeuwin–Naturaliste Ridge are the major areas of water use, concentrating the pressure on the resources in these areas.

As one of the fastest growing areas of the state, the land use in the plan area continues to change. Land-use changes, especially development of the Swan coastal plain, lead to subsequent changes in water use, especially increased demand for public water supply and local domestic and garden bores. Changes to rural land use and re-zoning have also increased the number of smaller irrigation projects in place at the larger water using operations. Of particular note is the increasing trend in subdivisions and re-zoning of land from broad scale agricultural to viticulture and rural lifestyle blocks.

Recent water use and compliance surveys highlighted that there are some areas where licensees are not using their full groundwater allocations. In fully or near fully allocated areas, this prevents other potential users from accessing this water to expand their business or begin new operations, reducing industry potential in the South West. Some licensed entitlements were recouped in 2003 and 2004, allowing this water to be reallocated for further use.

The policies in this plan generally support *Statewide policy no 11* (WRC 2003b) on recouping any unused portions of licensed water entitlements for reallocation to other productive uses. The exception is water that has been saved through improved water use efficiency as identified in the policy section of this plan (See Chapter 5).

Public water suppliers

There are three licensed water service providers supplying public drinking water in the plan area from groundwater resources. They are the Water Corporation, Bunbury Water Board (Aqwest) and the Busselton Water Board.

Population growth in the plan area has lead to an increase in the amount of groundwater abstracted and treated for public water supply purposes. In recent years, due to the expanding urban development and increases in transient (tourism) and permanent populations along the Swan coastal plain, there has been an increase in the demand for public water supply.

Local governments are beginning to apply stricter water use efficiency requirements on new developments and water conservation and efficiency plans (see Section 5.1) are being developed between the department and local government authorities to further improve efficiency measures.

For more information and statistics on water service providers including licensed allocations and reserved water see Chapter 4 and Appendix C.

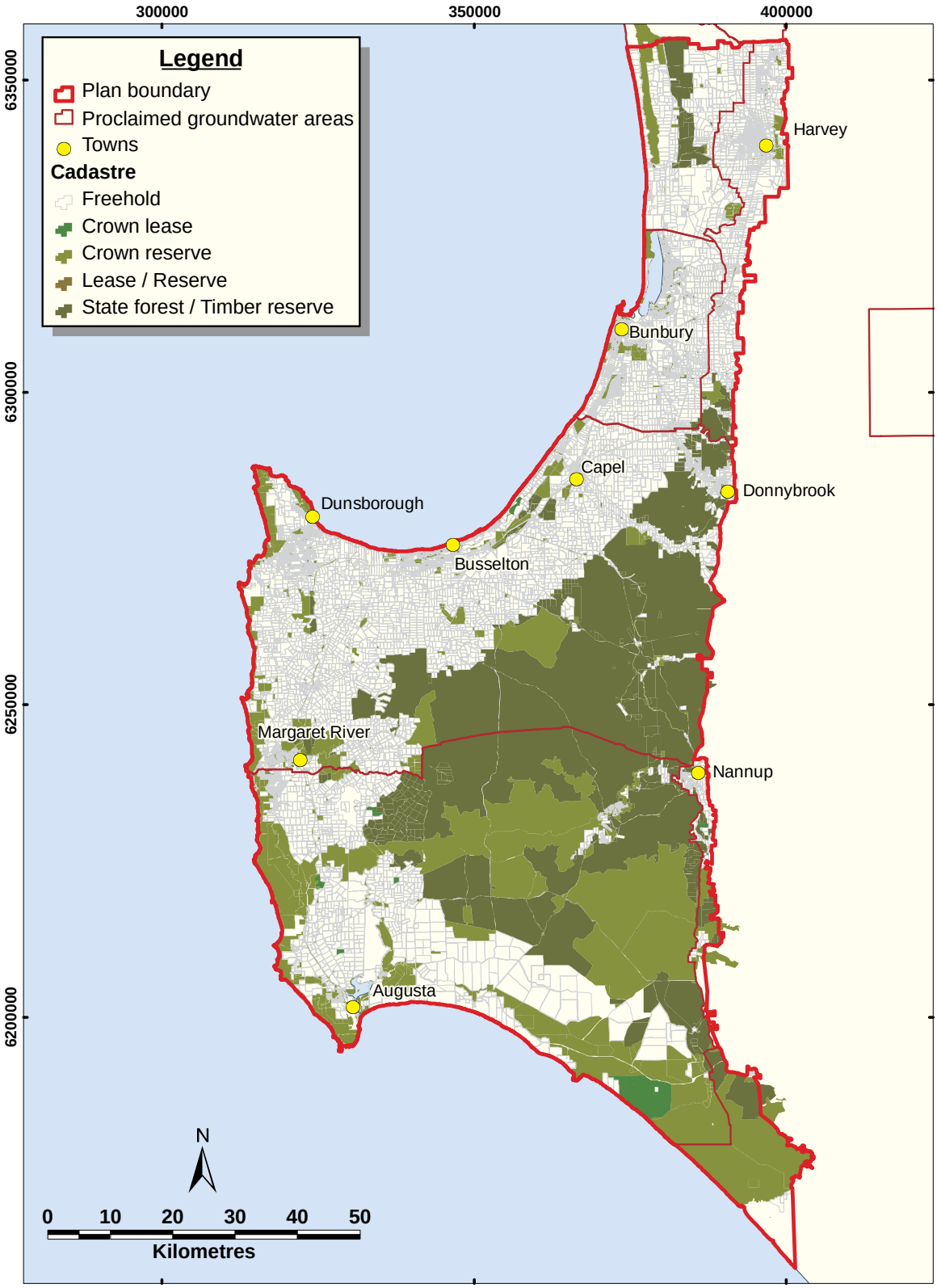


Figure 9
Freehold and crown land (including state forest)

Water management and use implications

Water is a limiting factor for economic growth in the South West. The department recognises this and has reserved groundwater for future public water supply in the region (Section 2.8) to accommodate population growth, while encouraging more efficient and cost-effective use of groundwater for all industries. The constraints of climate change and its impact on recharge and rainfall runoff is also likely to restrict growth in the future.

Existing licensed entitlements, unlicensed and/or exempt domestic, stock and garden use are protected in this plan through the allocation limit decision-making process. This process has allowed for some water to be available for consumptive use in the Superficial, Leederville and some minor aquifers on the coastal plains (see Chapter 4 and Section 2.8).

Action 10 – Carry out water use surveys in priority areas and report on outcomes at a subarea level.

Action 11 – Review public water supply licences and reserved water requirements to meet the water efficiency objectives of this plan.

Recommendations for licence applicants

- Water available for expansion or new developments will be restricted by the allocation limits and policies set in this plan.
- If you believe more water can be taken sustainably from an aquifer in a given area than the allocation limits allow, you may choose to investigate the groundwater resource in order to prove additional water can be abstracted with no unacceptable effects on existing users or environmental values.
- If you propose to prove more water is available contact the department before beginning the investigations, as a licence will not be issued if we are not satisfied the investigation work has proven additional water can be sustainably taken for the duration of the proposed abstraction period.

2.8 Future demand for water

Economic projections and future water demand reports have been undertaken for the plan area and are listed in the bibliography. The estimates of future demand from these are shown below. They may change depending on market forces and product demand.

Public water supply demand

Consumption of water for public water supply in the South West groundwater areas is projected to grow by up to 10 GL over the next 25 years. In Brennan (2007) an examination of existing public water supply licences revealed that it was likely that unless additional water was made available some towns would face shortages of scheme water over the next few years. This shortfall will be met by reviewing existing public water supply licensed entitlements, which are currently greater than the future demand predictions.

Any future water use for public drinking water will be required to meet water use efficiency targets in line with the per person consumption targets (< 100 kL/person) (DPC 2007b). Although the target is specifically for Perth based household consumption, the department encourages water service providers to meet this target across the state.

Irrigated agriculture

Studies using the rate of growth in produce markets (including the export markets) and land availability in the region have been used to estimate the potential future water demand for irrigated agriculture. These studies included those conducted by Economic Consultancy Services 2003a, 2003b and 2005, and Brennan 2006 and 2007. However, these studies did not take into account water being a limiting factor for development.

2 Considerations for water management

It should be noted that the forecast agricultural water demands presented in these studies are an indication of the potential for irrigation demand, but actual water use will be limited by water resource scarcity. Under more extreme water scarcity, where the irrigated horticulture and viticulture sector competes with town, mining and industrial sectors for water, growth will be restricted beyond the 30-year forecasts.

Ministerial and other departmental commitments

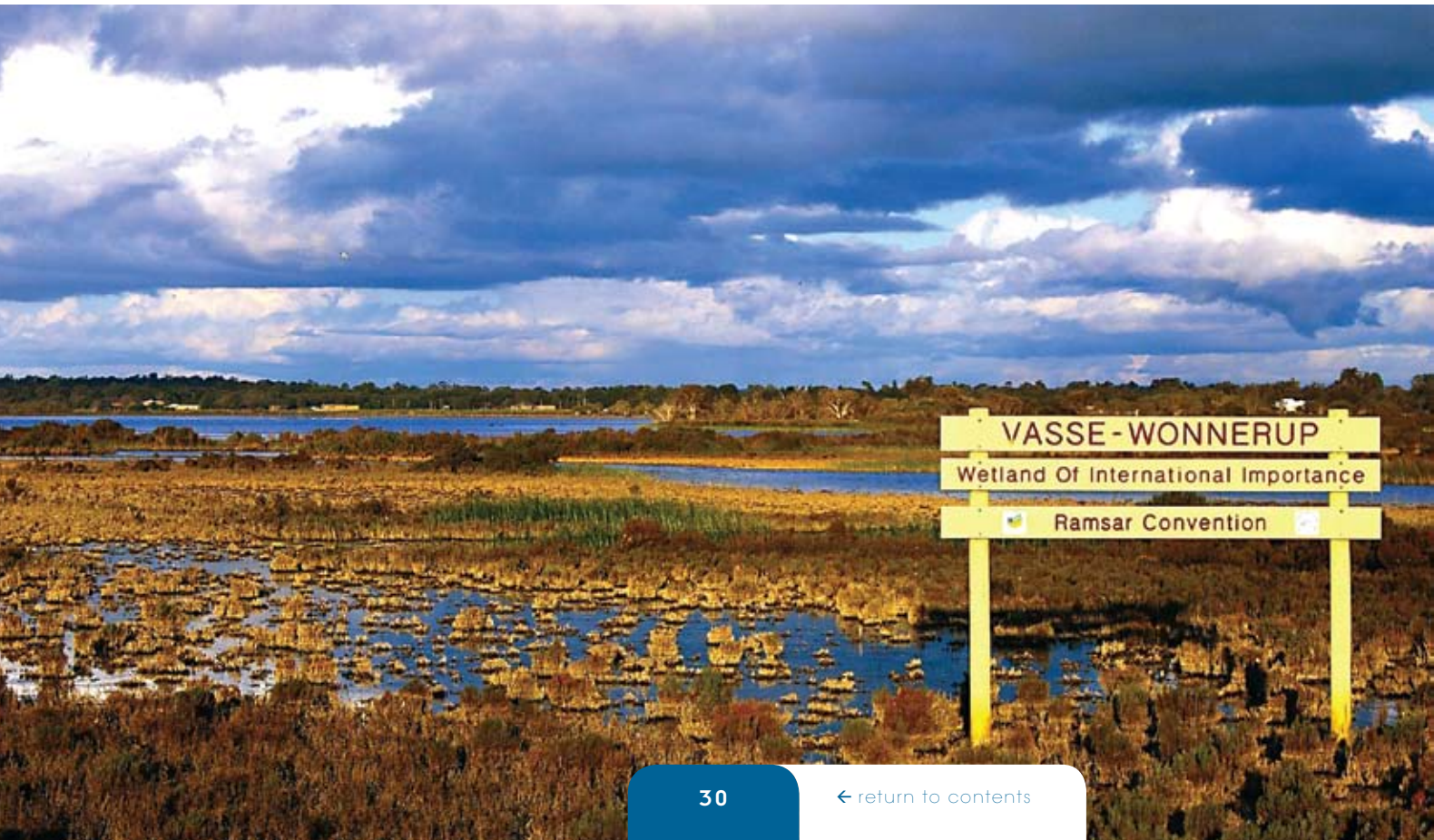
Public water supply

The state government and the Department of Water have reserved groundwater for high value public water supplies to 2036 for the South West region. The decision to reserve this water (largely from the Yarragadee Aquifer), and to secure a source to meet the anticipated growth in demand, aims to minimise the health risk of contaminating future drinking water sources. Details of the reserve are shown in Appendix C and an explanation of how this reserve may be accessed is given in Section 5.1.

Mineral sands mining

The state government has acknowledged, prior to this plan being developed, the important economic contribution of mineral sands mining to the South West and that mine water use is short-term (< 10 years at each site). As a result the normal circumstances in which groundwater can be traded (policy 12.1.1 only) do not apply. The special exemption applies to Iluka Resources Limited and Cable Sands (Bemax Resources), which operate within the plan area.

The exemption to policy 12.1.1 only allows for these mining companies to move their water use from one mine site to the next. However, this agreement remains subject to the 10-year licence time frame, the licence assessment process and the policies for trading outlined in this plan (Section 5.1 and 5.2) and does not apply to trading their entitlements with other licensees.



Water management and use implications

The department manages water resources to minimise the risks to a reliable supply. By improving water use efficiency, industries can make more water available to meet demand.

Water has been reserved for public water supply (Table 3) to meet the expected demand in population growth in the major towns in the South West. Access to water for all other sectors will be restricted by the available water for each subarea and aquifer. In areas of high demand for water and low availability (allocation) we will actively recoup unused licensed entitlements and implement trading of water.

Water use efficiency will be driven by the value of water and efficiencies increased through the adoption of new technologies. Benchmarks for water efficiency change as new technologies and practices are developed. It is up to the licensee to investigate which systems are applicable to their water use activity. The implementation of water use efficiency measures is encouraged in all water use sectors.

Action 12 – Investigate the potential for short-term temporary licensed entitlements from the public water supply reserve.

Recommendations for licence applicants

- As part of becoming more water efficient you should review your licence entitlement and look for opportunities to improve your water use.
- Where water may be unavailable from the desired water resource to meet future applications, we will identify other water resources or trading as potential options to satisfy demand and provide this information to applicants.
- Where water trading is implemented in areas that have become fully allocated, or where water use efficiency measures have resulted in a reduction in water use, the volume saved can be traded within a fully allocated resource.

2.9 Community input into planning

Water allocation planning recognises and seeks community input through existing community and representative groups and through targeted consultation activities. Throughout the community consultation period for this plan, the department has recorded the major issues that have been raised by the community and aims to address each of these through our planning processes (Table 1) and further investigation work.

Table 1 provides a summary of the issues gathered prior to the release of this plan for public comment (February 2008) and incorporates the comments received through this process. For more information on the comments received through the public review process and the department's responses please see *Statement of response – South West groundwater areas allocation plan, (*DoW 2009f).

The most important issue voiced by the community is that there is a need for careful management of groundwater resources to protect the environment and the current users, who range from small domestic users to larger agricultural and industrial users. A major theme from the department's experiences in community consultation is the need for openness and accountability in decision-making and the need to base those decisions on good scientific knowledge and understanding. This will increase community confidence that future use is sustainable and that management will be continually improved as further investigations increase our understanding of the resource.

Table 1
Summary of community issues

	Community Issues	How will these issues be addressed?
Hydrogeology	Water availability – how much can be drawn from the aquifer sustainably?	See Section 4.1, Table 3
	Recharge – where are the recharge areas for different aquifers? What are the recharge rates?	See Box 2, Section 2.1 or for more information see the bibliography.
	Monitoring – what monitoring will be done and has been done to manage the aquifers?	See Chapter 6 or South West groundwater areas monitoring program, Department of Water (DoW 2008g).
	Aquifer interrelationships – how do the aquifers interact with each other and with surface water systems?	This is currently being investigated further. Our current knowledge can be found in the documents listed in the bibliography or you can explore our website for new and up-to-date information.
	Seawater interface – how is it managed?	The seawater interface will be managed through responsible allocation limits (Chapter 4), ongoing licence assessment (Chapter 5), investigations and monitoring (Chapter 6).
	Climate change – is this taken into account when modelling groundwater?	See Box 4 (Section 2.2), Section 4.1 or Reviewing the allocation limits for the South West groundwater areas (DoW 2008a).
	Water quality – how will the influence of abstraction on water quality be managed and monitored? How will the use of water be managed to reduce impacts such as nutrients in groundwater systems or waterways?	See Chapter 6 or South West groundwater areas monitoring program (DoW 2008g). Licensees will also be required to monitor water quality for various types of activities. Please see Section 5.1 for more information.
	Acid sulfate soils – how will they be managed?	See Sections 5.1, 5.2 and 6.2 or South West groundwater areas monitoring program, (DoW 2008g).
	What will be done so that forests and nature reserves are not affected by abstraction?	Not all forested areas are groundwater-dependent and therefore not all will be affected by abstraction. Generally, modelling has shown most potential GDE will be maintained at a low level of risk over the next 30 years. Some areas may be at higher risk, as a result of climate change and existing groundwater use. Monitoring is in place at representative GDE sites and a management response will be taken if adverse trends occur to biological or water resource condition (Section 6.2). Investigations are continuing into both the groundwater resource and ecological water requirements of GDE.
Ecology	Will potential impacts be managed for wetland and lake systems such as Lake Jasper?	Yes, through our regional and local scale monitoring (Section 6.1), our management zones (Section 5.2), and trigger and response criteria (Section 6.2).
	Is there any impact on marine systems?	This has been considered in the development of the allocation limits. In maintaining the current seawater interface (throughflow to the ocean) for each of the aquifers any impacts on offshore groundwater discharges is unlikely.

Table 1
Summary of community issues

	Community Issues	How will these issues be addressed?
Ecology	What could be the impact on the salinity of rivers e.g. Blackwood River if fresh water discharge is reduced?	There may be some increase in summer salinity if groundwater discharge to the Blackwood River is reduced. However, unacceptable reductions in discharge are not anticipated under the proposed allocation limits. Investigations are underway into the complex relationships between groundwater abstraction and discharge into the Blackwood River and into salinity tolerance thresholds of native fish in the Blackwood River (report due in 2009).
	What are the local and regional future water needs?	Future water requirements may change depending upon market demand and the economy. Estimations of future demand have been used in the modelling and in understanding the needs of public water supply (population growth). All economic assessments are listed in the bibliography.
Economic	Will the plan ensure that future water supplies are available for local communities?	Where water is available demands can be met (Table 3). Water has been reserved for public supply in the region for local towns (Section 4.3).
	Will future population growth be taken into account in planning?	Future demand and population growth in and around existing urban areas has been taken into account through the public water supply reserve, management considerations and setting the allocation limits (Section 2.8 and 4.1).
	What is the true cost of town water supply?	The cost of town water supply is set by the public utility that supplies the water.
	How will the existing water supplies for agriculture be protected?	Current and existing use has been accounted for in setting the allocation limits. This includes accounting for current impacts and likely future impacts. The policies in the plan will also protect existing use (Table 4 to Table 10).
	How are plantations managed?	See Section 2.9
	How can allocation limits address the current and future agricultural needs?	Prevention of unacceptable environmental impacts and ensuring security for existing users are priority issues when setting allocation limits. In some resources it was not possible to make more water available without compromising these factors. Where water is not available alternative water sources or trading may meet demand.

Table 1
Summary of community issues

	Community Issues	How will these issues be addressed?
Social	Aboriginal heritage values – will the plan ensure cultural values linked to water resources are protected?	Cultural water dependent sites are protected through the same means as groundwater-dependent ecosystems of high ecological value in the planning process. Investigations are underway to review social and cultural water values (Action 7).
	European heritage values – will these be protected?	European heritage values are protected in the same way as cultural values across the plan area.
	Recreational reserves – what are the risks to reserves, how will they be managed?	Reserves are managed by DEC. We ensure that the risks of groundwater abstraction to high value GDE within reserves are protected through the policies in the plan (Table 4 to Table 10), allocation limits (Section 4.1) and monitoring (Section 6.2).
	Equity issues – distribution of a resource, how can it be done equitably?	Our existing policy of first-in first-served applies in areas where water is still available. In areas which are fully allocated or over allocated trading policies will apply.

Current issues

Self management

The irrigation review and water reform process identified that irrigation cooperatives have produced many benefits for agricultural producers and water management in Western Australia (see Irrigation Review Steering Committee 2005, DPC 2007a). Cooperatives are a form of self management whereby a non-government entity takes on the operational management of a local water resource (for example, Harvey Water).

The department is in the process of investigating the potential for self management by self supply users in the plan area. Evidence has shown that collaborative self management of water is feasible and has many benefits. However, self management for self supply groundwater users has yet to occur in Australia. This type of self-supply management requires further investigation and informed policy development is required.

Action 13 – Investigate options to allow greater collaboration between the department and water users, working towards a potential self management model for use in the future.

Plantation management

As identified in Table 1, the management of plantations is of interest to the South West community. The department has accounted for existing plantations on the coastal plains in developing the allocation limits for the Superficial Aquifer.

While plantations do intercept recharge and use groundwater, the current legislation (*Rights in Water and Irrigation Act 1914*) does not provide for the management or licensing of water use by plantations. It is proposed that new legislation will regulate water use by plantations and other water intercepting activities, where necessary.

Local government authorities are currently the lead decision-makers on plantation proposals, with advice from the department. Work is being carried out by the department and other agencies to better understand the impacts of plantations. We are working with community

groups, local government and plantation industry representatives to develop a state wide position and policy on plantation water use to complement new legislation.

Under new water legislation being prepared the department will be able to account for and manage plantation water use and this will be reflected in the statutory water management plan in 2011.

Action 14 – Develop guidelines to clarify policy and arrangements for managing water use by plantations under the current legislation.

Water management and use implications

In response to the community's request to be kept informed of local water resource conditions and progress of research and management activities, the department will report on the various commitments listed throughout the plan and describe how we are meeting the plan actions and objectives. This will be reported through the annual evaluation statement outlined in Chapter 7. This information will be made publicly available to ensure that the community has access to the most up-to-date information of water resource management in the South West.

The community will be consulted on the ongoing work to review this plan and their concerns will be recorded and reported on in the annual evaluation statement. All documents associated with meeting the reporting requirements of this plan will be made publicly available on the department's website <www.water.wa.gov.au>.

Action 15 – Develop a program for stakeholder consultation for the review of this plan.

Recommendations for licence applicants

- Under current legislation, applications for proposals to take water may require advertisement. Where this applies you will be required to submit a public notice regarding your proposal. The department may request further information to help address community concerns regarding the proposal.

2.10 Other water related plans and strategies

This plan has considered a range of other government plans and strategies developed by the Department of Water and other agencies. These are listed in the associated plan companion documents – subarea reference sheets.

Recommendations for licence applicants

- If you are going to change your current water use activity, or develop a new activity, you must consider other relevant governmental legislation and policies. The department will not issue licences for activities that are not in line with existing government legislation and policies.
- Your water access and use should be consistent with the range of policies for your area. Reviewing these documents and early liaison with departmental licensing officers may speed up the processing of a licence application or trade.

Part two

Allocation and management framework

Chapter three

Objectives and strategies

3.1 Objectives

The objectives for managing groundwater in the South West groundwater areas are based on the considerations in Chapter 2. The department will, where appropriate, initiate additional investigations and monitoring programs to ensure that management objectives are met.

The objectives of this plan are:

- to keep the risks from groundwater abstraction to identified ecological, cultural and social values at an acceptable level
- to maintain groundwater quality for fit for purpose use so that there is an acceptable level of risk to the environment and water users
- to protect the security of supply for water users
- to ensure that water users use groundwater in the most efficient way
- to increase accountability for water use and its associated impacts
- to recover over-allocated groundwater resources
- to reserve groundwater for the public drinking water needs of South West communities
- to provide licensees with consistent information on licensing requirements and decisions.

Each management objective has associated strategies (Table 2) and performance indicators to determine if the plan and its implementation are meeting the objectives.

3.2 Strategies and performance indicators

The department will be meeting the objectives of this plan through the implementation of a range of strategies and measuring the objectives against performance criteria (Table 2). The strategies include:

- managing the allocation limits
- meeting the actions of this plan
- licensing groundwater use against the policies in this plan
- applying the department's position for water management against a specific objective.

Not every objective requires the use of all types of strategies. The applicable strategy type and the associated notes are detailed in Table 2. The performance indicators will be reported on in the annual evaluation statement (see Chapter 7) as part of implementing the plan. For a complete list of the actions referred to in the strategies column please see Table 14 and Table 15 in Chapter 7.

Table 2
Strategies and performance indicators for meeting each objective

Objective	Strategy	Performance indicator*
To keep the risks from groundwater abstraction to identified ecological, cultural and social values at an acceptable level.	**Allocation limit**: environmental water provisions are met through the development of the allocation limits. **Actions**: 2, 4–7, 9 and 20 (a–e). **Policy**: implement the policies and management zones (Chapter 5; Appendix B and E). **Position**: implement *Management triggers and responses for groundwater-dependent ecosystems in the South West groundwater areas* (Del Borrello 2008).	**Number of management triggers breached and/or responded to for all GDE sites as per *Management triggers and responses for groundwater-dependent ecosystems in the South West groundwater areas* (Del Borrello 2008).**
To maintain groundwater quality for fit for purpose use so that there is an acceptable level of risk to the environment and water users	**Actions**: 2, 4, 20 (a–e) and 21. **Policy**: implement the policies and management zones (Chapter 5). **Position**: implement *South West groundwater areas monitoring program* (DoW 2008g).	**Number of monitoring sites which register an adverse change (>10% increase between reporting periods) in water quality (pH, salinity, acidity, nutrients) as a result of abstraction post 2009 based on pre-recorded levels from:** • **departmental monitoring network** • **licensee monitoring bores** Number of licensees who registered and submitted a change in their water quality data to the next salinity threshold (Table 5).
To protect the security of supply for water users	**Allocation limit**: licensing within the allocation limit of each resource provides a level of security to a share of the resource in the future. **Actions**: 10–11 and 17–18. **Policy**: implement the policies and management zones (Chapter 5).	**Publish annual resource assessments of recharge, discharge, and throughflow for all aquifers, and the movement of the seawater interface.** Conduct a comprehensive assessment of groundwater levels every four years as described in South West groundwater areas monitoring program (DoW 2008g). Number of directions issued to licensees by the department to stop or reduce their take of water (including the volume change in kL/yr).
To ensure that water users use groundwater in the most efficient way.	**Actions**: 10–11 and 17–19. **Policy**: implement the policies and management zones (Chapter 5).	**Publish the annual evaluation statement and include the volume of metered use as a percentage of the volume of total licensed entitlements (for licences > 5000 kL/yr).** Percentage change from 2008 to 2011 in volume of metered water use compared with licensed entitlement (by industry group, resource and subarea). Percentage change in the average annual usage per capita for each public water supply licence. Volume of water efficiency gains reported by licensees through their annual monitoring reports compared with previous use.

Table 2
Strategies and performance indicators for meeting each objective

Objective	Strategy	Performance indicator*
To increase accountability for water use and its associated impacts	**Actions**: 10–11, 17–18 and 22. **Policy**: implement the policies and management zones (Chapter 5).	**Publish the annual evaluation statement and include data collected as part of meeting objectives 4, 6, 7 and 8.** This may also include: • annual volume licensed and exempt by resource and subarea • number and type of licence condition breaches and the level to which enforcement action was take by the department • total number of licences issued annually from each resource by subarea.
To recover over-allocated water resources	**Actions**: 10 and 17–18.	**Publish annual evaluation statement and include the number and volume of water over the allocation limit for all resources.** This may also include: • percentage of the total resources over allocated across the plan area • annual percentage change in amount of water licensed over the allocation limit by resource and subarea • volume of water recouped from unused water entitlements each year by resource and subarea (kL/yr).
To reserve groundwater for the public drinking water needs of South West communities	**Actions**: 11 and 12. **Policy**: implement the policies and management zones (Chapter 5).	**Publish the annual evaluation statement and include the volume of water held in public water supply reserve (kL/yr) and licensed to public water service providers by resource and subarea (kL/yr).**
To provide licensees with consistent information on licensing requirements and decisions	**Actions:** 15, 19 and 22. **Policy**: implement the policies and management zones (Chapter 5).	**Publish the annual evaluation statement and include licensing data by resource and subarea.**

*Key performance indicators are in bold, with supporting indicators listed below.

Chapter four

Water allocation

4.1 Allocation limits

An allocation limit is the volume of water that can be taken from a water resource after decisions have been made about what water must be left in the system to support ecological, social and cultural values, maintain the seawater interface and account for the likely effects of climate change.

The allocation limits have been reviewed and updated for the plan area (Table 3). The methodology and process followed in reviewing the allocation limits is detailed in *Reviewing the allocation limits for the groundwater resources of the South West groundwater areas* (DoW 2008a).

Allocation limits may be revised during the life of this plan based on improved information on the resource gained from further investigation and ongoing measurement and monitoring. Any changes to the allocation limits will be publicly reported, through advertisement in the state and local newspapers, media statements and on the department's website.

Allocation limits are set for each aquifer in a subarea, referred to as a resource (Table 3). There are some instances where a subarea may contain small areas of an aquifer (generally < 30 km^2 along boundary lines). Although the regional scale mapping of the hydrogeology may show the presence of an aquifer, on ground investigations may prove otherwise. As a result the allocation limit for these resources has generally been set low, while still meeting any existing licensed entitlements. For a full list of up-to-date resources and water availability contact one of the department's three South West district offices.

Action 16 – Review the allocation limits with improved information in 2011.

4.2 Subareas

Subareas are management units within each groundwater area. Their boundaries are based on hydrogeological information, such as fault lines or major aquifer features. Allocation limits and use information is provided on a subarea basis, and in some cases specific licensing policies apply. To find out which subarea a property is located in contact one of the department's three South West district offices.

The subareas for the Superficial and Leederville aquifers (Figure 10) are defined along hydrogeological boundaries and are aligned with the closest cadastral feature (such as a road or property boundary). This is to avoid a single landowner having different allocation policies on either side of their property.

The subareas for the Yarragadee and other deep aquifers (Figure 11) are defined on the groundwater area boundaries and key geological boundaries. The subareas for the Yarragadee are larger than the Superficial and Leederville boundaries reflecting the regional nature of the aquifer and the potential for impacts to be transferred across large distances.

Prospective licensees and licensing officers need to be aware that within a 2 km buffer along either side of the subarea boundary line the aquifer may or may not be accessible, and that hydrogeological investigations may be needed.

4.3 Water availability

Water availability is the allocation limit less the existing uses of water (licensed use, exempt use, reserved allocations). This gives the volume of water currently available for licensing (Table 3). Water availability will change as new licences are issued or existing licences are cancelled. To find out the most up-to-date water availability figures following release of this plan please contact one of the department's three South West regional offices.

Within the plan area water is available for allocation in some of the resources (Table 3). However, the department has received applications for water across all resources and most resources are expected to become fully allocated over the next few years.

Table 3 indicates where water is available as at January 2009 and it is important that any new proponents contact the department before submitting an application to confirm whether there is any remaining water for allocation in their subarea.

Action 17 – Carry out compliance surveys in all fully-allocated and over-allocated aquifers and subareas.

Action 18 – Initiate processes to recoup unused water entitlements.

Fractured rock

The fractured rock resource does not have an allocation limit. However available water will be assessed on an impact management basis as per the licensing policies and local policies in this plan. Please see Section 5.1 and the subarea reference sheets for more information.

Over-allocated subareas

An analysis of measurement data and modelling information has shown that in some areas there is currently too much water being taken out of the system. In Table 3 this is represented as an over-allocation of water in these resources. In most cases this over-allocation is actually a result of the lowering of existing limits to take account of likely future reductions in recharge due to climate change, or where declines in the groundwater table have been observed. Consequently, areas that were already close to or at full allocation under the previous allocation limits are now over-allocated.

In these areas the department will seek to reduce the amount of over-allocation by reviewing current licensees' use of water. The department will recoup any water that has been allocated but is not being, or has not been, used. The over-allocated resources will be carefully monitored over the term of this plan to ensure there are no adverse impacts to the environment, the resource or existing groundwater users from this over-allocation. If, at the end of the planning period in 2011 the system remains in an over-allocated state and impacts have become apparent, further action will be taken to reduce abstraction.

Unproclaimed areas

Part of the plan area is unproclaimed (Bunbury–Karri and Blackwood–Karri subareas). These areas do not have allocation limits set as only artesian groundwater can be licensed under the *Rights in Water and Irrigation Act, 1914*. However, all licensing policies covering the artesian aquifers apply to these areas (Table 4).

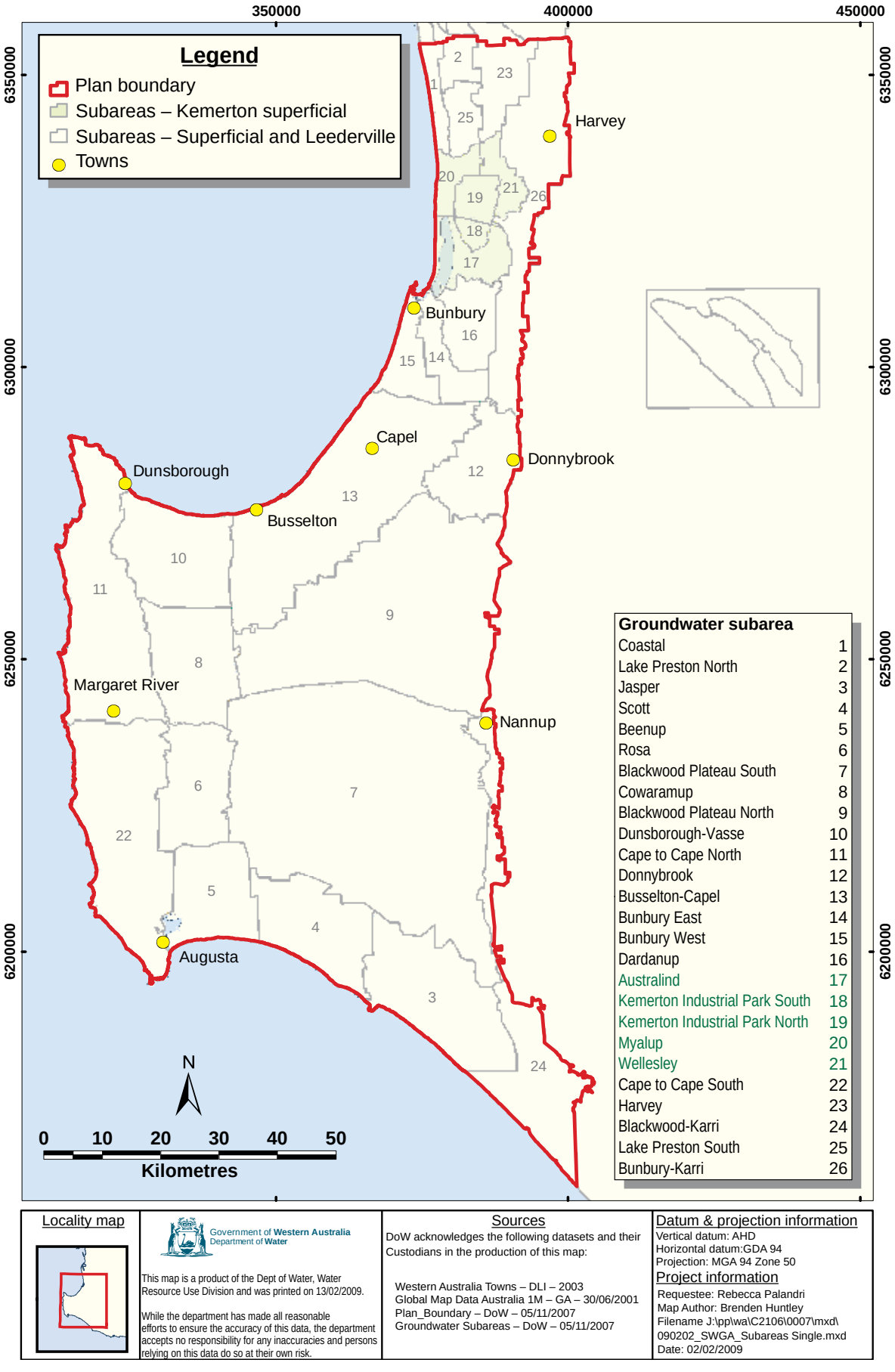


Figure 10
Groundwater subareas for the Superficial and Leederville aquifers

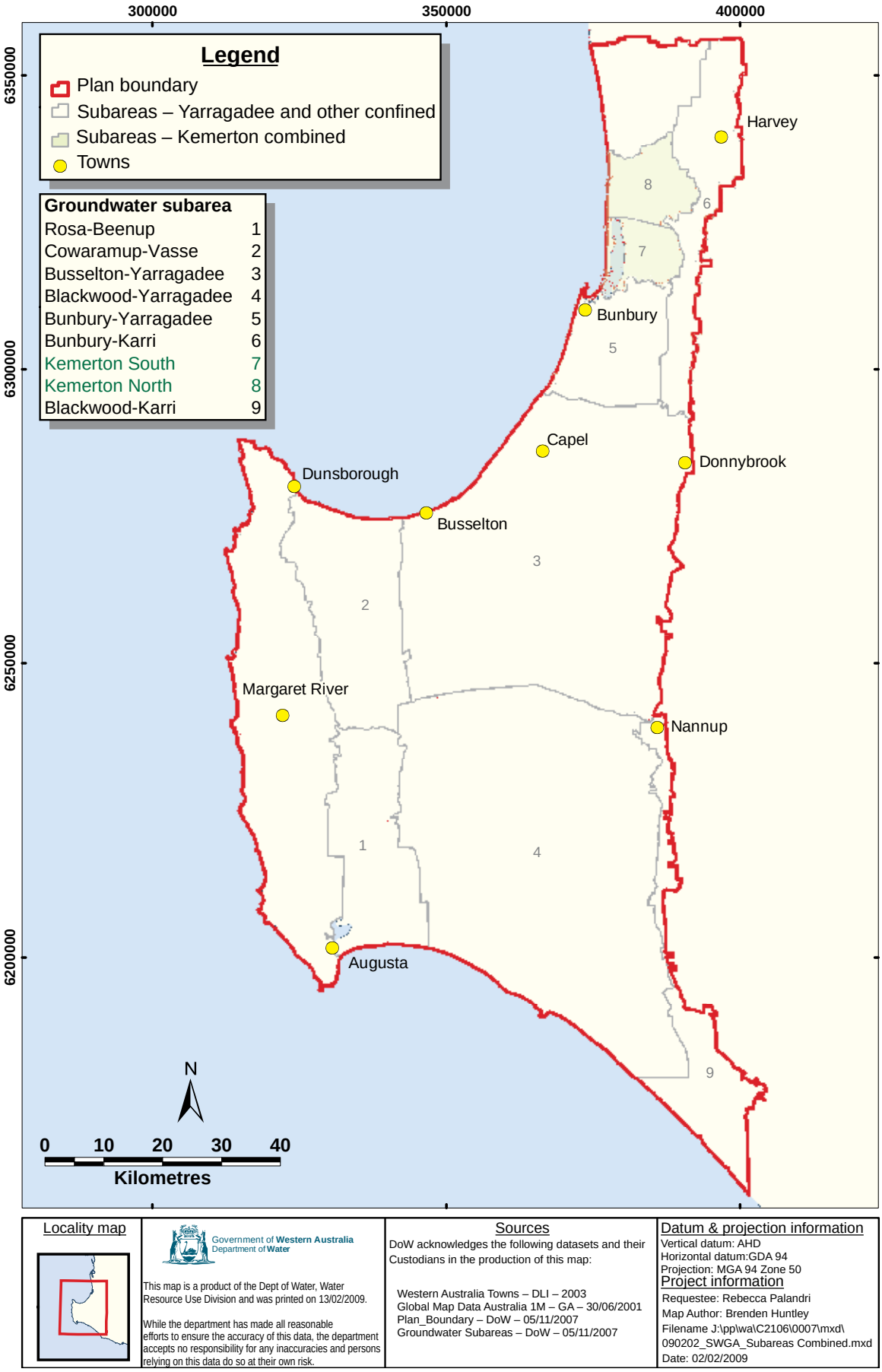


Figure 11
Groundwater subareas for the Yarragadee and other aquifers

Table 3
Groundwater allocation limits and available water[1] (kL/yr)

Groundwater area	Resource		Allocation limit [3]	Licensed entitlements [2]	Estimated exempt use	Reserved	Water available [5]
	Subarea	Aquifer					
South West Coastal (part in plan area)	Lake Preston	Leederville	500 000	420 000	10 000	0	Limited availability
	Lake Preston North	Superficial	9 300 000	1 195 200	10 000	0	Water available
	Lake Preston South	Superficial	10 500 000	11 386 740	10 000	0	Over-allocated
	Harvey	Superficial	11 500 000	1 737 300	10 000	0	Water available
		Leederville	50 000	0	0	0	Water available
	Kemerton North	Leederville	3 500 000	150 000	0	3 000 000	Limited availability
		Cattamarra	6 000 000	0	0	0	Water available
	Kemerton Industrial Park North	Superficial	790 000	18 900	20 000	0	Water available
	Myalup	Superficial	7 350 000	6 579 250	10 000	0	Limited availability
	Wellesley	Superficial	2 150 000	878 000	10 000	0	Water available
Bunbury	Australind	Superficial	690 000	652 700	181 000	0	Fully allocated
	Kemerton South	Leederville	5 000 000	4 874 250	50 000	0	Limited availability
		Cattamarra	4 000 000	992 000	0	0	Water available
	Kemerton Industrial Park South	Superficial	210 000	196 950	7 000	0	Fully allocated
	Bunbury West	Superficial	2 000 000	984 050	200 000	0	Water available
		Leederville	35 000	0	10 000	0	Restricted
	Bunbury East	Superficial	685 000	347 310	50 000	0	Water available
		Surficial	15 000	0	0	0	Fully allocated
		Leederville	2 000 000	1 812 400	0	0	Limited availability
	Dardanup	Superficial	290 000	49 000	10 000	0	Water available
		Surficial	5000	0	0	0	Restricted
		Leederville	3 500 000	3 102 800	0	100 000	Limited availability
	Bunbury–Yarragadee	Yarragadee	26 500 000	20 242 750	400 000	5 700 000	Fully allocated
Busselton–Capel	Busselton–Capel	Superficial	7 200 000	4 055 665	400 000	0	Water available
		Surficial	800 000	32 000	100 000	0	Water available
		Leederville	10 500 000	8 165 650	0	0	Limited availability
	Donnybrook	Superficial	5000	0	0	0	Restricted
		Surficial	495 000	372 040	50 000	0	Water available
		Leederville	2 400 000	2 417 975	0	137 000	Over allocated
	Dunsborough–Vasse	Superficial	2 500 000	1 618 510	300 000	0	Water available
		Surficial (Leeuwin)	1 400 000	1 288 400	150 000	0	Fully allocated
		(Blackwood)	600 000	565 700	50 000	0	Fully allocated
		Leederville	5 400 000	5 500 075	0	0	Over allocated
	Cowaramup	Surficial (Leeuwin)	10 000	0	0	0	Restricted
		(Blackwood)	890 000	615 700	25 000	0	Water available
		Leederville	1 800 000	724 800	25 000	0	Water available
	Cowaramup–Vasse	Sue Coal/ Lesueur [6]	4 000 000	1 005 000	0	0	Water available
		Yarragadee	10 000	0	0	0	Restricted
	Cape to Cape North	Surficial (Leeuwin)	890 000	667 695	120 000	0	Restricted
	Blackwood Plateau North	Superficial	5000	0	0	0	Restricted
		Surficial	45 000	0	0	0	Restricted
		Leederville	250 000	6 500	50 000	0	Water available
	Busselton–Yarragadee	Yarragadee	45 500 000	44 848 550	0	350 000	Fully allocated

return to contents

Table 3
Groundwater allocation limits and available water[1] (kL/yr)

Groundwater area	Resource		Allocation limit [3]	Licensed entitlements [2]	Estimated exempt use	Reserved	Water available [5]
	Subarea	Aquifer					
Blackwood	Blackwood Plateau South	Superficial	0	0	0	0	Restricted
		Surficial	50 000	1500	0	0	Restricted
		Leederville	250 000	94 000	3 000	0	Water available
	Cape to Cape South	Surficial (Leeuwin)	585 000	314 225	100 000	0	Restricted
		(Blackwood)	5000	0	0	0	Restricted
		Superficial	5000	0	0	0	Restricted
		Leederville	10 000	0	0	0	Restricted
		Lesueur/Sue Coal [6]	10 000	0	0	0	Restricted
	Rosa	Surficial (Leeuwin)	5000	0	0	0	Restricted
		(Blackwood)	95 000	149 600	15 000	0	Restricted
		Leederville	1 000 000	605 100	0	0	Water available
	Beenup	Superficial	1 370 000	0	10 000	0	Water available
		Surficial (Leeuwin)	5000	0	0	0	Restricted
		(Blackwood)	25 000	22 400	0	0	Restricted
		Leederville	1 000 000	401 150	0	0	Water available
	Rosa–Beenup	Lesueur/Sue Coal [6]	4 000 000	3 156 000	0	1 000 000	Fully allocated
	Scott	Superficial	1 990 000	91 000	25 000	0	Water available
		Surficial (Blackwood)	10 000	0	0	0	Restricted
		Leederville	3 200 000	24 000	0	0	Water available
	Jasper	Superficial	1 800 000	0	10 000	0	Water available
		Surficial (Blackwood)	200 000	0	0	0	Restricted
		Leederville	50 000	0	0	0	Limited availability
	Blackwood–Yarragadee	Yarragadee [4]	15 500 000	8 845 000	0	3 000 000	Limited availability
Total			**212 435 000**	**141 197 835**	**2 412 000**	**13 287 000**	

Notes:

1 The water available is current as at January 2009. Any further allocations will reduce the amount of water available. Please refer to the department's licensing system or contact the department for an update on water availability.

2 Licensed entitlements are current as of January 2009. The estimates of unlicensed use are based on local knowledge, water user surveys and a desk top review of aquifer location, depth and number of lots for domestic and garden use in small lots and larger lots with stock water. Farm dam mapping has also been used to determine estimated use from stock soaks and excavations.

3 Where an allocation limit is between 0–50 000 kL/yr the aquifer may be present but is restricted to a certain portion of the subarea or is discontinuous across the subarea. Many of these resources are < 30 km^2 and the limits have been assigned to account for existing licensed entitlements or a notional limit for accounting purposes. These aquifers are listed as restricted as a result of their hydrogeology and location. To access these resources you will be required to undertake hydrogeological investigations to prove that the resource can be abstracted sustainably.

4 The Sue Coal, Lesueur and unconfined Yarragadee are managed together within this allocation limit, though the aquifers are separate.

5 Restricted means that there may or may not be water available from this aquifer (contact one of the South West district offices). A detailed hydrogeological investigation will be required before the aquifer can be accessed. The department's information on these resources is limited.

6 The Lesueur and Sue Coal Measures aquifers are managed together within this allocation limit, though the aquifers are separate.

Chapter five

Allocation and licensing

Allocation and licensing policies are developed to ensure water is allocated in an equitable and considered way. Allocation policies provide advice on where and under what circumstances water may be taken and how water abstraction is managed.

All state and Commonwealth legislation relating to water and its use apply to this plan area. All statewide policies endorsed by the department apply to this plan. Specific aspects of existing statewide policies were developed further to be more applicable at a local scale for the management of water resources in the plan area.

The allocation policies were developed to support the principles and objectives of the plan. They were developed in the context of a competing atmosphere for consumptive water, and aim to provide a sound basis for groundwater licensing over the life of the plan. The policies aim to protect *all* groundwater use and as such cover ecological, social and economic aspects, as well as water quality and quantity.

Licensing decisions should be based on the best available scientific knowledge, and through the decision-making process, take into consideration local and regional scale impacts of abstraction. All licensing decisions must be in line with this plan. Licensing of groundwater in the plan area is administered by the department's South West regional offices.

High value groundwater-dependent ecosystems, areas of social or cultural significance, and sites of potential acid sulfate soil risk that may be affected by abstraction may have local area policies applied to them in addition to the policies outlined in Section 5.2. These additional requirements are in place to protect high value areas or areas at high risk of impact. Trigger and response criteria also apply to some sites.

The licensing process and licence application forms can be found on the department's website or by contacting one of the department's three South West regional offices. Applicants should be aware of the licensing policies that may apply to their area before submitting their groundwater licence application to the department.

5.1 Policies for water take and use

Allocation policies (Table 4 to 10) are required by the department to ensure that available water is allocated in accordance with the *Rights in Water and Irrigation Act 1914*. They provide the structure for assessing and issuing licences. Policies also act as guidance to ensure water is allocated in line with ecological, social and economic considerations in the plan area. All licence applications will be assessed in accordance with the department's statewide policies on licensing and the policies stated in this plan. A full list of the statewide policies, including a brief description, is available on the department's website <www.water.wa.gov.au> and listed in the subarea reference sheet documents (2009c–e).

Table 4
Licensing policies for the taking and use of groundwater in the plan area

Policy group		Policy detail	
1	**Allocating water**		
1.1	Allocation approach	1.1.1	Groundwater licences in the plan area will be allocated on a 'first-in first-served' basis up to the allocation limit, except in areas covered in policy 1.1.2 or where it is an application to trade (see Table 6).
		1.1.2	In areas that are close to full allocation, fully allocated, or in any Yarragadee subarea, alternative water allocation processes such as expressions of interest, auctions or merit selection, may be used to release water. This will support the establishment of a market and ensure that the value of water is recognised. The department will advertise well in advance when and how the release will be managed, and provide advice to all interested parties including proponents who have applied for any remaining water.
		1.1.3	A groundwater licence to construct (26D) or take water (5C) is required under the *Rights in Water and Irrigation Act 1914* for all uses from a confined aquifer.
		1.1.4	A licence to construct (26D) or take water (5C) is required under the *Rights in Water and Irrigation Act 1914* from an unconfined or watertable aquifer where the use is not exempt from licensing (see policy 4.1.1, and policy 8.1.1).
1.2	Hierarchy of water allocation	1.2.1	Environmental requirements of the groundwater resources (in situ use) are met through determining the available water for allocation. The hierarchy for allocating the available water is public drinking water supply (through the reserve), then domestic water supply and finally all other consumptive uses.
		1.2.2	Private domestic water supply requirements in areas with no access to scheme water must be satisfied before water is allocated for other uses, including in fully allocated areas.
1.3	Releasing future water		Water may be released for licensing in two ways: • Water is made available as a result of licences expiring or where water is recouped from users who are not using their full water entitlements in 2009. • The allocation limit is increased following completion of groundwater investigations, or when new information becomes available. All changes to allocation limits will be publicly stated in the annual evaluation statement for this plan, and licensees and applicants will be notified.
1.4	Reaching the allocation limit		When the licensed entitlements for a given groundwater resource reaches the allocation limit, any further applications for new entitlements, other than a trade, will be refused. Where allocation limits are increased and more water becomes available policy 1.1.2 will apply. Refused applicants may be contacted to be part of this process.
1.5	Localised allocation		If potential localised impacts associated with a groundwater application are found to be unacceptable for a specific groundwater resource, the application is likely to be refused. This may occur even where the application is within the allocation limit.

Table 4
Licensing policies for the taking and use of groundwater in the plan area

Policy group		Policy detail	
2	Water use and supply		
2.1	Efficient water use	2.1.1	Water should be used efficiently and proponents should show how their water use will be efficient with regard for industry standards or best management practices. Larger operations may be required to demonstrate water conservation measures before additional water can be allocated.
		2.1.2	Where water efficiency gains are achieved as a result of implementing more efficient distribution systems, the excess allocation of the licensed entitlement can be traded and will not be recouped by the department, provided that use has been proven. Where a change of purpose occurs for a licensed entitlement (e.g. pasture irrigation converting to irrigation of wine grapes) the subsequent excess allocation can be traded, provided that use has been proven.
2.2	Alternative water supply	2.2.1	If alternative supplies such as recycled, drainage, desalination or reuse of reinjected water are part of a proposal, contact the department as early as possible to determine the approval and supporting information required.
		2.2.2	Where multiple water resources (ground and surface water; shandying) are used on a property and the combined total water use is > 50 000 kL/yr the abstraction points are required to be metered to demonstrate the amount being abstracted from each source.
2.3	Fit for purpose use	2.3.1	Where possible, uses requiring lower quality water should be matched with appropriate sources. In areas of limited high quality water availability, proposals may need to be altered to allow for the use of lower quality water such as high nutrient, saline or recycled water.
		2.3.2	If alternative supplies such as recycled, drainage, desalinated or reinjected water (managed aquifer recharge) are part of a proposal, contact the department as early as possible to discuss any management or licensing issues.
2.4	Cape to Cape water use	2.4.1	In the Cape to Cape North and South subareas, a maximum allocation of 20 000 kL/yr for a new licence applies (specified on 5C licence).
		2.4.2	A pumping test for a new bore is advised to assist in determining the local aquifer yield at the proposed draw point (specified on 26D licence).
		2.4.3	The location of a draw point in the Cape to Cape North and South subareas may be restricted by a set distance (as defined on the 26D licence) away from a defined water course, wetland or karst system.
3	Licensee responsibilities		
3.1	Application requirements	3.1.1	It is the individual licensee's responsibility to provide the department with information requested to enable the complete assessment of their licence application. Any requested information will be assessed in accordance with *Statewide policy no. 17 – Timely submission of required further information* (DoW 2007a).
		3.1.2	With the licensee's permission all information submitted by a licensee on water levels, water chemistry, abstraction (metered use) and hydrogeological work (including any local models) will be used in the department's reporting on resource conditions.

Table 4
Licensing policies for the taking and use of groundwater in the plan area

Policy group		Policy detail	
3.2	Renewal of groundwater licences	3.2.1	It is the licence holder's responsibility to make an application to extend the term of the existing licence before the expiry date. Any licence application submitted after the expiry date will be treated as a new licence application.
		3.2.2	In fully allocated areas, licensees must not allow their licences to expire as the department cannot guarantee that the licence will be renewed if the water is not available.
		3.2.3	At renewal, an expired licence in a fully allocated area may have more stringent conditions placed upon it.
4	Licensing rules and requirements		
4.1	Assessment process	4.1.1	Groundwater abstraction from any aquifer in the plan area is licensed as per the *Rights in Water and Irrigation Act 1914*. Exemptions may apply for some water use activities.
		4.1.2	When an application is received for a new bore, two licences will be issued: • 26D licence for the construction of the bore • 5C licence only after a valid borehole log and completion details, or Form L – Particulars of completed borehole, has been received from the proponent and the aquifer has been identified. For guidance regarding the construction, cement grouting and abandonment of bores see <www.water.wa.gov.au> Publications > find a publication.
4.2	Bore construction	4.2.1	Following completion of the bore construction it is the licensee's responsibility to submit Form L or a certified driller's borehole construction report, including lithology, surveyed level of bore geophysical log and pump test results before a licence to take (5C) the water is issued.
		4.2.2	The construction, modification or decommissioning of monitoring and abstraction bores must be in accordance with *Groundwater monitoring bores*, Water quality protection note no. 30 (DoW 2006e) and *Minimum construction requirements for water bores in Australia* (NMBSC 2003).
		4.2.3	For new applications > 500 000 kL/yr into a confined aquifer a geophysical log must be submitted to the department. The department will assess the geophysical log and associated information (e.g. pump test; lithology) and provide advice to the applicant on where the bore can be screened. Forty-eight hours notice must be given to the department before drilling commences.
		4.2.4	The department will provide advice to the licensee on the time frame, disposal or discharge location for the pump test water for any pump testing that is required in the construction of a production bore. This may include treatment of the pump test discharge water to ensure that there are no impacts associated with its disposal. The hierarchy of preferred pump test water disposal is as per dewater discharge (policy 8.2) in this plan.
		4.2.5	Bores abstracting groundwater from a confined aquifer are required to be pressure cement grouted through overlying aquifers to stop intermixing of groundwater with varying water quality. Tremmie cement grouting is required for watertable aquifer bores to ensure that the bore is protected from above-ground contamination.

Table 4
Licensing policies for the taking and use of groundwater in the plan area

Policy group		Policy detail	
4.3	Depth requirements for bores		Where the regionally confined aquifer thickness is greater than 200 m, bores drilled into this aquifer should be staggered in depth, as well as laterally, to more efficiently utilise the groundwater resources and minimise drawdown impacts on the aquifer and its users.
4.4	General licensing requirements	4.4.1	The standard licence tenure for new commercial licences will be managed in accordance with *Statewide policy no. 9 – water licensing – staged developments* (WRC 2003a). Upon meeting the development conditions the licence tenure becomes 10 years unless otherwise stated on the licence.
		4.4.2	The standard licence tenure for public water supply and any domestic, stock and garden licences is 10 years unless otherwise stated on the licence.
4.5	Licence required for stock, domestic and garden use	4.5.1	Aquaculture is considered to be stock raised under intensive use in the plan area and is not exempt from licensing.
		4.5.2	Where a licence is required for domestic and garden use in urban areas and scheme water is available, a maximum of 500 kL/yr entitlement applies. Where a licence is required for domestic, stock and garden use in semi-rural and rural areas, and scheme water is not available, a maximum of 1500 kL/yr entitlement applies. Existing licensed entitlements may be amended.
		4.5.3	Allocations for intensive stock production must be based on the water requirements per head of stock (within the allocation limit). Allocations for commercial garden irrigation (e.g. botanic garden, entrance statements) must be based on the plant's watering requirements per hectare. Water supply for domestic residences for commercial purposes is 150 kL/yr/residence (e.g. chalets).
		4.5.4	Irrigation of gardens, lawns and recreational areas from all bores is restricted to between the hours of 6 pm and 9 am all year round. Alternate day water restrictions from groundwater bores apply to irrigation of gardens, lawns and recreational areas.
4.6	Recouping unused water entitlements		The department may reduce unused portions of licensed entitlements in accordance with *Statewide policy no. 11 – Management of unused water entitlements* (WRC 2003b).

Table 4
Licensing policies for the taking and use of groundwater in the plan area

Policy group		Policy detail	
4.7	Metering	4.7.1	All new groundwater licences > 50 000 kL/yr or as specified in a management zone are subject to a condition requiring the installation and maintenance of a department approved flow meter (*Rights in Water and Irrigation (approved meters) Order 2003*) for each draw point. Installation must be in accordance with the *Guidelines for water meter installation* (DoW 2007e).
		4.7.2	Metered bores are to be read monthly, with readings submitted annually as per the date specified in the licence conditions. The frequency of meter readings can be increased or decreased as per the risk assignment in *Statewide policy no 19 – Hydrogeological reporting associated with a groundwater well licence* (DoW 2007b).
		4.7.3	All abstraction (< 50 000 kL/yr) with the potential to unacceptably impact on another existing user and/or groundwater-dependent ecosystem will be required to be metered in case mitigation measures are required.
		4.7.4	Any communal bores used by one or more landholders, with access to the bore for consumptive purposes, must be metered, where the combined use is > 50 000 kL/yr.
		4.7.5	It is the responsibility of licensees to ensure that the water pumped is of a quality to be metered to prevent damage to the meter. The department may at any time require a meter to be tested by the licensee.
4.8	Staged developments	4.8.1	All applications for new developments will be assessed as per *Statewide policy no. 9 – Water licensing – Staged developments* (WRC 2003a).
		4.8.2	A detailed development plan and timetable stating the proposed activity, the area of development and the timeframe for each stage of development must accompany all new or amended licence applications.
4.9	Operating strategies	4.9.1	The department may require the development and implementation of an operating strategy (*Statewide policy no 10 – Use of operating strategies in the water licensing process*, WRC 2004) where: • the taking of water may impact on the environment • the volume of water to be taken is significant (> 100 000 kL/yr) • a hydrogeological report is required under *Statewide policy no 19* (DoW 2007b) • the water resource requires stringent management (within a management zone – Section 5.2) • water is abstracted from several sources or from a number of bores and requires careful management • in the opinion of the department, it is necessary in order to fulfil the requirements of the *Rights in Water and Irrigation Act 1914* and Regulations 2000.
		4.9.2	Operating strategies are to be developed in conjunction with the licensee, with all conditions and requirements in the strategy to be auditable and appropriate for the purpose of the abstraction, (see *Statewide policy no. 10,* WRC 2004). Information submitted in the operating strategy will be used by the department to develop licence conditions associated with the abstraction and monitoring of the licence application.

Table 4
Licensing policies for the taking and use of groundwater in the plan area

Policy group		Policy detail	
4.10	Groundwater investigations	4.10.1	In certain circumstances, proponents of a proposal may be required to submit to the department a hydrogeological report in accordance with *Statewide policy no. 19* (DoW 2007b).
		4.10.2	Information submitted as part of a hydrogeological assessment to support a groundwater well licence application, will be used to assess the possible local and regional impacts of the proposed abstraction on the hydrology, environment (see policy 5.2) and other groundwater users. The report is to be prepared by a qualified groundwater professional and completed at the applicant's expense.
4.11	Monitoring program	4.11.1	Licensees may be required to prepare a monitoring program, undertake regular monitoring and submit the results to the department, in accordance with *Statewide policy no. 19* (DoW 2007b).
		4.11.2	Applications for a licence > 500 000 kL/yr or requiring a H2/H3 risk assessment may be required to install one or more water level monitoring bores, unless it can be demonstrated to the department's satisfaction that a monitoring bore is not required (e.g. existing monitoring bore can be used).
		4.11.3	The licensee is responsible for monitoring, maintaining and constructing a private monitoring bore. Results of the measurements are to be submitted together with the metering results annually.
		4.11.4	Private monitoring bores must be located on land owned by the licensee or land that the licensee has legal access to. The department will provide advice to the licensee on the preferred location of the monitoring bore.
		4.11.5	The frequency and duration of the measurement of the static water level readings (m AHD) or water quality parameters will be defined in the licence conditions and will be reviewed on an annual basis. The frequency and duration of the monitoring period will reflect the level of impact and risk associated with the licence application assessment.
5	Environmental policies		
5.1	Environmental legislation	5.1.1	All proposals requiring a groundwater licence must also comply with relevant environmental legislation as well as the policies contained in this plan.
		5.1.2	If a project requiring water is submitted where the scale or scope means that it cannot be fully considered under this plan and the *Rights in Water and Irrigation Act 1914*, the proposal may be referred to the Environmental Protection Authority (EPA) for advice. The department will assess the groundwater-licence application and incorporate EPA advice where relevant.
		5.1.3	Where the department receives a water licence application for a proposal which requires assessment by the EPA under the *Environmental Protection Act 1986*, the department will use any advice or information which arises from the EPA process in finalising the water licence assessment. Approval for a project by the EPA does not mean a water licence is approved.

Table 4
Licensing policies for the taking and use of groundwater in the plan area

Policy group		Policy detail	
5.2	Environmental impacts and licence assessment	5.2.1	If an application is likely to have a significant impact on a groundwater-dependent ecosystem, then the applicant will be required to provide an assessment of the environmental values and the potential impact that the proposed abstraction will have on the ecosystem as per *Statewide policy no. 19* (Dow 2007b) and Appendix E.
		5.2.2	Depending on the proximity to groundwater-dependent ecosystems, the location and abstraction rates for new abstraction points will be specified by the department to minimise the impacts of abstraction. This does not apply to the construction and location of monitoring bores.
5.3	Environmental monitoring	5.3.1	In cases where impacts from abstraction may be expected, monitoring may be required. This may include monitoring water levels, water quality, species composition and biological condition as determined by the department.
		5.3.2	Where monitoring is required a monitoring program should be developed by the licensee as part of an operating strategy (as per policy 4.8) to measure the predicted impacts on the system and/or evaluate the success of offset and mitigation measures.
5.4	Water level criteria (triggers and responses)		Licences may contain conditions referring to meeting specific water level criteria (environmental water requirement (EWR) water levels, triggers and responses) where applicable. This may include restrictions on abstraction, additional monitoring or management, release of water, supplementation, and location of new draw points as determined by the department.
5.5	River baseflow		Where a new licence application is submitted that has the potential to decrease the groundwater contribution to the river baseflow during low flow periods (generally summer months) the department may request additional monitoring, specify the location of the draw point or restrict the volume of water drawn during a particular time period.
5.6	Environmental offsets and trade-offs	5.6.1	*Environmental offsets – position statement no. 9* (EPA 2006) will be applied in the department's assessment of a proposal requiring trade-offs or offsets. Any costs associated with recovery of impacts resulting from the abstraction and/or the offsets and trade-off measures will be borne by the licensee.
		5.6.2	Supplementing water flows or water levels is a valid offset measure but must be shown to be compatible and achievable for the purpose of maintaining a specified water level and water quality for a given system. Short-term (e.g. life of mine site < 10 years) supplementation of water levels and quality may be considered, with recovery to baseline conditions or as defined by the department (prior to abstraction). Ongoing supplementation will not be considered as an offset measure for groundwater abstraction without ministerial approval.
5.7	Acid sulfate soils		When an application is submitted for a project, which occurs in an area of high risk of generating acidic water or soils, applicants must prepare appropriate documentation to support their application. This may include an acid sulfate soil management plan. These applications to take water will not be granted until appropriate management arrangements are approved by the Department of Environment and Conservation. For more information on acid sulfate soils please see: <www.dec.wa.gov.au/management-and-protection/acid-sulfate-soils/index.html>

Table 4
Licensing policies for the taking and use of groundwater in the plan area

Policy group		Policy detail	
5.8	Contaminated sites		Applications to take water from an identified contaminated site will not be considered unless appropriate management arrangements are approved by the relevant authorities (including Department of Environment and Conservation and the Department of Health). For more information on contaminated sites please see: <www.dec.wa.gov.au/pollution-prevention/contaminated-sites/index.html>.
5.9	Pollution events		Point source pollution of groundwater through industrial or other activities is regulated through the *Environmental Protection Act 1986*. The EPA should be contacted if there is evidence of a pollution event.
6	Water quality		
6.1	Water quality	6.1.1	The department may require a licensee to monitor, measure, and report on salinity, acidity and other analytes as part of the licence conditions if it considers that their water use may affect these parameters. Water use must not increase the background levels such that it adversely affects a water-dependent system (including other users). This includes activities such as dewatering, excavating, application of nutrients, discharge of waste water and irrigation or processing with saline water.
		6.1.2	A licensee must report any increase to the existing salinity of the groundwater resource in use (to the next higher threshold category in Table 5) to the department within seven days. The department will provide advice to the licensee and may restrict pumping from this source until the salinity levels return to the baseline conditions. This may include amendment of licence conditions, increased monitoring and remediation. Where a proposal has the potential to affect groundwater quality the department may apply additional licence conditions to manage any associated impacts and protect the water resource and dependent systems.

Table 5
Salinity threshold categories (Australian Government 2004)

Salinity type	TDS range mg/L
Fresh	< 500
Marginal	500–1000
Brackish	1000–2000
Moderately saline	2000–5000
Saline	5000–10 000
Highly saline	10 000–35 000
Hypersaline	> 35 000

	6.1.3	The department's water quality protection information should be used in assessing licence applications which have the potential to impact on water quality. In particular information contained in the *Nutrient and irrigation management plans*, Water quality protection note no. 33 (DoW 2006c) should be applied.

Table 4
Licensing policies for the taking and use of groundwater in the plan area

Policy group		Policy detail
6.2 Nutrient impact management		Applicants may be required to provide an operating strategy for proposals with the potential to contaminate water sources through the application of fertilisers and nutrients. To demonstrate how they will manage potential impacts, the applicant may also be requested to provide a Nutrient and irrigation management plan (NIMP) prepared as per the *Nutrient and irrigation management plans,* Water quality protection note no. 33 (DoW 2006c) as part of their operating strategy (policy 4.9). This includes activities where the site: • is irrigated with wastewater from intensive animal industries and/or municipal wastewater treatment plans • has intensive animal holding in paddocks (e.g. feedlot, dairy) • is irrigated land where fertilisers, chemical pest control and animal wastes are routinely applied (e.g. turf farms, summer pasture, woodlots, sport and recreational facilities) • is an intensive horticultural pursuit in or near an environmentally sensitive area, public water supply reserve, underground water pollution control areas or natural water body. The information submitted by the licensee will be used in the licence assessment process to specify the licence conditions and/or additional monitoring and measurement requirements in an operating strategy.
6.3 Seawater interface	6.3.1	Groundwater abstraction from the watertable aquifer near the coast should be limited to minimise the risk of the seawater interface moving inland.
	6.3.2	Where the watertable aquifer is accessed, the installation of multiple spaced bores with low flow pumps are recommended, to spread the drawdown. The department will provide advice on the location of the bores and if monitoring is required.
	6.3.3	If the interface is found to be intermixing with an aquifer the department may restrict pumping along the coast or require draw points to be moved to protect the aquifer.

Table 4
Licensing policies for the taking and use of groundwater in the plan area

Policy group		Policy detail	
7	Social and cultural		
7.1	Urban land use and development	7.1.1	All urban land requiring groundwater for irrigation of parks, gardens, public open space and maintenance of artificial wetlands or constructed lakes must provide the department with a water conservation and/or efficiency management plan. It should detail the whole water balance cycle including the water re-use and recycle systems, metering and monitoring requirements, irrigation schedule, and time frame for development of new areas. The plan will be assessed by the department and will be used to develop licensing conditions and monitoring requirements.
		7.1.2	Groundwater required for urban development is not considered to be a part of the drinking water reserve and must be applied for from within the allocation limit or through trading. Alternatively, groundwater supply can be negotiated with a public water service provider as part of a water supply agreement.
		7.1.3	All new urban developments should be in line with *Better urban water management strategy* (WAPC 2008).
		7.1.4	All new urban land use developments will be assessed as per *Statewide policy no. 9 – Water licensing, staged developments* (WRC 2003a).
		7.1.5	Anyone changing or applying to change land zoning or expand an urban development should consult with the department before gaining planning approvals to ensure that any dewatering or potential irrigation requirements can be met.
7.2	Cultural sites		All applicants are required to meet any statutory requirements under the state's *Aboriginal Heritage Act 1972* or the Australian Government's *Native Title Act 1993* where applicable.
7.3	Drinking water source protection		All licensed activities must be undertaken in accordance with any public drinking water source protection plan implemented by the department for a given water resource.

Table 4
Licensing policies for the taking and use of groundwater in the plan area

Policy group		Policy detail	
8	Dewatering		
8.1	Dewatering	8.1.1	The *Rights in Water and Irrigation Exemption (Dewatering) (Section 26C) Order 2005* applies to all parts of the state that are proclaimed areas for the purposes of Section 26B of the Act.
		8.1.2	All dewatering activities that are not exempt must be licensed, including the discharge of wastewater into the environment.
		8.1.3	Where a licence is required for dewatering, an operating strategy may be requested by the department to address the impacts of the dewatering proposal. In all cases the following information must also be submitted with the licence application: • detailed project description • proposed start date and duration of project • the need for, extent and details of dewatering required, including the proposed approach for abstraction • the likely rate and volume of dewatering and description of how the dewater will be treated and disposed of. The following information may be requested where impacts are likely: • information on managing risks of exposure of acid sulfate soils (as per policy 5.4) • a hydrogeological investigation (as per policy 4.9) – this may include a local area groundwater model to determine the extent of the groundwater drawdown • groundwater level and quality measurements • construction of local monitoring bores (e.g. piezometers) • water reuse or disposal methods and associated monitoring (as per policy 8.2) • water conservation and efficiency plan for significant dewatering operations (> 6 months duration, pump rate > 5 L/sec, regionally confined aquifer) where water is disposed of or reused. This information will be used to assess the licence application and proposed approach for dewater discharge or reuse.
		8.1.4	Groundwater monitoring bores should be installed to measure water levels and quality on a regular basis, to determine if dewatering is influencing the background levels (pre-dewatering). The department will advise the licensee when monitoring is required.

Table 4
Licensing policies for the taking and use of groundwater in the plan area

Policy group		Policy detail	
8.2	Dewatering discharge	8.2.1	The following are the department's preferences for acceptable methods for discharging high quality dewater: • use for fit for purpose activities on site (e.g. processing and dust suppression, irrigation) to reduce the volume of release. The proponent needs to show that it is of suitable quality for the purpose of use. • allow to infiltrate over an expanse of land designated by the department for the operation • reinject back into the watertable aquifer at designated sites specified by the department • allow to flow (either through a pipe or overland) into a designated drain, defined water course or wetland (protected by legislation) specified by the department — provided no significant erosion is predicted or water quality impacts observed.
		8.2.2	In areas where the dewatering discharge is treated and of low quality the options in 8.2.1 can be used. However the department must approve the type of use, discharge rate, location and any subsequent treatments required, to minimise potential impacts. This includes where mitigation measures may be needed. The department will specify the appropriate method of dewatering discharge following consultation with the licensee.
		8.2.3	The water quality of the dewatering discharge should be measured before and after any treatment processes. See *Dewatering of soils at construction sites* (DoW 2006d) and *Mining and mine processing – mine dewatering* (WRC 2000b), for more information.
		8.2.4	Where impacts on water quality, water levels or other users (including the environment) occur outside the area of operation, they must be immediately reported to the department. The department may direct pumping to cease until the impacts of the dewatering operation are addressed. The department will advise the licensee if any remediation is required as a result of the impact.
9	Public water supply and other major projects		
9.1	Water use efficiency	9.1.1	A water efficiency and conservation plan (as per *Statewide policy no 16 – Policy on water conservation and efficiency plans*, DoW 2008h) must be submitted by a public water service provider as part of the licence assessment process. Additional water from the reserved allocation will not become available until water efficiency targets have been reached.
9.2	Access to the reserve	9.2.1	The water service provider must notify the department of their intent to access the public water supply (PWS) reserves and will be required to submit a PWS source development plan to the department (see 9.3.1). These source development plans will provide the department with information on when future demand will require access to the PWS reserve and whether all reasonable efficiency measures have been applied beforehand.
		9.2.2	Public water service providers cannot access reserved water until triggers for new sources are reached as per the department-approved source development plan.

Table 4
Licensing policies for the taking and use of groundwater in the plan area

Policy group		Policy detail	
9.3	Source development plans	9.3.1	Public water service providers will be required to develop a source development plan in collaboration with the department of water when requesting to access a reserve (future needs) for drinking water. The source development plan shall include, but will not be limited to, information on forecasting demands, buffer volume to meet potential rapid increases in demand, identification of resources to be accessed to satisfy demands, and options or investigations planned to develop the identified resources. Water service providers should liaise with the department to further identify the requirements of source development plans.
		9.3.2	In areas of PWS with a high risk of contamination, or potential decrease in supply due to surface water and groundwater supply changes, drought contingency plans should be developed as part of the source development plan. These should document the implementation of drought management and emergency supply options.
		9.3.3	Assessment of applications received prior to this plan will be continued in their current form, without the requirement of source development plans.
9.4	Major projects	9.4.1	Major projects requiring water (>500 000 kL/yr) for production or development may involve assessment by, or advice from, other government departments (e.g. EPA, WAPC, DIA, DPI and local governments) before a licence can be issued. It is important that the proponents of these projects come to the department early in their scoping phase rather than at the end when a licence is required, as there may not be enough water available for the project. Failure to do this may result in proponents having to repeat work and lose significant time to satisfy departmental requirements or may find that their operation is no longer feasible due to water management or availability issues.
		9.4.2	For all major projects a water conservation and efficiency plan will be required before assessment of the licence can be finalised.
9.5	Temporary allocation of reserved water	9.5.1	The department may temporarily allocate the unused portion of a reserve for another purpose, if it will not be accessed in a ten year time frame (identified through a source development plan).
		9.5.2	Any temporary allocation of the reserve is subject to the assessment process and will only be issued for 1 to 5 years duration. It cannot be traded and is not renewable.
		9.5.3	A maximum of 75% of the total reserved water for a given resource can be temporarily allocated at any one time.
		9.5.4	All temporary allocations will be subject to a legal agreement between the department and the licensee. The term of the licence tenure and lease arrangements (including market price) will be included in the agreement. The agreement is to ensure the water is returned to the reserve following the expiry of the temporary licence.
		9.5.5	If a public water service provider chooses not to use the reserved water it may be re-allocated back into the system for use.

Table 4
Licensing policies for the taking and use of groundwater in the plan area

Policy group		Policy detail
9.6	Exporting water out of the region	Future water use for sustainable regional growth and development will be satisfied before water is exported out of the region. The area to which the water is being exported must have a deficit of supply, with all other reasonable supply and demand management options implemented to the department's satisfaction.
10	Compliance and enforcement	
10.1	Water-use surveys	Routine water-use surveys will be conducted for all licensees every 3 to 5 years for entitlements > 50 000 kL/yr and upon renewal of licences < 50 000 kL/yr.
10.2	Compliance with licence conditions	10.2.1 A person who commits an offence against the *Rights in Water and Irrigation Act 1914* and Regulations 2000 may not be able to hold or trade a licence to take water.
		10.2.2 Licences may not be renewed if licensees have not abided by all licence conditions.
		10.2.3 Failure to comply with a licence or a licence condition may result in the department taking action in accordance with the department's *Enforcement and prosecution policy* (DoW 2008d).

Trading

Proponents applying for a new entitlement, or existing licensees wishing to expand their enterprises in a fully allocated groundwater resource, will need to purchase their entitlement from another licensee (trade). The ability to transfer or trade water entitlements is provided for by Schedule 1, Division 7 of the *Rights in Water and Irrigation Act 1914* and in *Statewide policy no. 6 – Transferable (tradeable) water entitlements in Western Australia* (WRC 2001). This plan clarifies the application of policy no. 6 within the plan area, providing a local context and further defining the policies associated with decision-making for trading.

All official trades (documented on the department's water licensing database) that have occurred in the plan area prior to this plan's implementation are recognised and acknowledged as a defined asset separate from the land. It is important to note that you can only trade water if you can demonstrate that you have *used* (measured through meter readings or other approved method) the water efficiently in accordance with your licence conditions and comply with the policies stated in this plan (Section 5.2) and *Statewide policy no. 6 – Transferable (Tradable) water entitlements for Western Australia* (WRC 2001).

The ability to trade water entitlements is necessary when there is no available water. Trading can occur in resources that are not fully allocated but this is unlikely to occur, as most users will prefer to get a new licensed allocation. Trading policies and restrictions are designed to protect the water resource from unacceptable impacts. Therefore all trades will be assessed as a new licence application. All statewide policies and the policies listed in Table 4 apply to a trade or transfer of a water licence.

Table 6
Additional policies for trading involved in the taking and use of groundwater in the plan area

Policy group		Policy detail	
11	**Licence assessment for a trade**		
11.1	Assessment process	11.1.1	The department may require additional information from the applicant to assess potential impacts of the trade, at the expense of the applicant. All applicants required to provide the department with additional information on their trade must comply with *Statewide policy no. 17* (DoW 2007a).
		11.1.2	Applicants must apply for trades on the prescribed forms available from the department and must pay the prescribed fee.
11.2	Approval to trade	11.2.1	A trade or transfer of a water entitlement cannot be finalised until the department has assessed and approved the licence application.
		11.2.2	Licensed entitlements cannot be traded if the department considers the use to be non-compliant with the original licence.
		11.2.3	The department may refuse a trade in order to: • prevent inefficient uses and monopolies in water • protect other users and the environment from unacceptable impacts • ensure that the outcomes are beneficial to the state • meet policy and planning objectives. Upon refusal, the applicant may appeal against the department's decision to the State Administrative Tribunal.
11.3	Reliability of supply		Licensees contemplating entering the trading market for an additional or new entitlement should ensure that the entitlement can be pumped sustainably before they enter into the trade and that the application complies with the provisions of this plan. This may require submission of an application to carry out exploratory works or pump testing (see *Statewide policy no. 19 – Hydrogeological reporting associated with a groundwater well licence,* DoW 2007b)

Table 6
Additional policies for trading involved in the taking and use of groundwater in the plan area

Policy group	Policy detail
12 Trading policies	
12.1 General	**12.1.1** Water cannot be traded between the groundwater resources defined in this plan (Table 3).
	12.1.2 Where licences are required for non-intensive stock, domestic or garden purposes they may not be traded. These licences will be transferred upon change of ownership of the land.
	12.1.3 The unused component of a licensed entitlement is not tradeable, subject to *Statewide policy no. 11 – Management of unused licensed water entitlements* (WRC 2003b).
	12.1.4 Trades are limited to the consumptive (used) part of the water entitlement. Accurate measurement of use of the water entitlement is a prerequisite for trading and must be proven to the department before the entitlement can be traded. The used component of the licensed entitlement is the amount of water actually abstracted for use.
	12.1.5 Licensees who do not have meters fitted to their production bores may not be permitted to trade until the licensee can demonstrate use over the period the licence has been in force.
	12.1.6 Fractured rock aquifer entitlements are not tradable.
	12.1.7 Dewatering entitlements are not tradable.
	12.1.8 Water efficiency gains can be traded and will not be recouped by the department.
12.2 Movement of water	**12.2.1** A trade must not result in an increase in the concentration of use (increase in abstraction within a small area) or impact on the environmental criteria set for that area.
	12.2.2 Trades can only occur where the proposed location and manner of use of the traded water has no detrimental impact on the water resource, water dependent systems or existing water users.
12.3 Environmental trades	An existing licensed entitlement for water can be purchased without demonstrating use if the entitlement is purchased for protection of an environmental asset (ecological, social or cultural asset). Water traded for this purpose is effectively traded for non-consumptive use (no abstraction) for the identified environmental asset. This water then becomes the property of the asset and can not be reallocated.
12.4 Market facilitation	The department will not be involved in setting the market price for trading of groundwater entitlements. However, the prices paid for trades will be publicly available from the department.

Table 6
Additional policies for trading involved in the taking and use of groundwater in the plan area

Policy group		Policy detail	
13	**Vendor and purchaser responsibilities**		
13.1	**New entitlements**	**13.1.1**	It is the responsibility of both the vendor and the purchaser to provide requested information to the department, including proof of use (measured through metering) as part of the licence assessment process.
		13.1.2	Trading of water entitlements involves a licence holder (vendor) trading all or part of their licensed entitlement to another water user (purchaser). A trade of a licensed entitlement can occur only with the approval of the department. Restrictions may apply.
13.2	**Leasing**		Leasing of licensed entitlements can only be accepted for a period less than the vendor's licence entitlement tenure, and only where impacts from the purchaser's bore location are acceptable for the duration of the lease agreement.
13.3	**Change in ownership**	**13.3.1**	When selling a property the owner (vendor) can apply to either transfer the licence to the new owner, trade the licence to a person(s) other than the new owner (purchaser), keep the licence and use it on another property or surrender the licence. Each change in ownership requires a new licence application.
		13.3.2	The volume of the traded entitlement will be added to the purchaser's existing or new entitlement. Licence conditions may be added to the licence to minimise/monitor potential impacts.
		13.3.3	Water licences are transferable upon sale of the land on which the bore, soak, pump or dam is situated. Water entitlements will not be altered providing water continues to be used in the same manner. However more stringent conditions may be applied.
		13.3.4	If a vendor's entitlement is traded permanently (full or part entitlement) the vendor's licence will be amended (partial trade) or cancelled (full trade).
		13.3.5	Where the trade is for the full licensed entitlement and the location of the draw point has changed, any further use of the vendor's bore(s) must cease. These bore(s) should then be fully decommissioned. If the vendor needs to continue to use the bore(s) following trading of the water entitlement, a new licence application is required.

Trading definitions

Agreement or lease

An agreement or lease is a temporary trade of a licensed entitlement (part or full entitlement) and is generally an annual lease from one licensee to another. The term of the lease or agreement must be less than the vendor's licence tenure specified on the licence.

Temporary and permanent trades have different considerations for impacts and a temporary trade may have acceptable impacts (subject to departmental decisions) as it is only short term – whereas a permanent trade to the same area may be refused or have more stringent conditions placed upon it, as it is presumed to be for a longer term of abstraction.

Proof of purchase

Proof of purchase must be submitted to the department following approval to trade. It is the responsibility of both the vendor and the purchaser to ensure adequate contractual documentation is used in the trade. There are two types of proof that can be submitted:

1. *Proof of purchase – licensed entitlement*: The price of the entitlement purchased, the volume purchased, the location of the draw point, and purpose of use must be supplied to the department to finalise the trade.

2. *Proof of purchase – water associated with the sale of land*: Where land has been bought with 'water' included in the sale price, the volume of water purchased and the price of the water must be clearly defined in the bill of sale and on the transfer of licence ownership.

The volume of water associated with the sale of land is not considered to be a traded entitlement in resources where allocation limits have not been reached and trading has not officially commenced. Any water purchased prior to the 2000 amendments to the *Rights in Water and Irrigation Act 1914* is not considered an official trade as water was available in the plan area and the potential for trade was not legislated. This means that any land purchased with water included in the sale price has no 'water' value other than the infrastructure associated with the water use.

Exempt stock, domestic and garden use

Domestic and stock water demand is acknowledged as a priority need for all landholders in areas where there is no scheme water supply. *Statewide policy no. 14 – Managing unlicensed groundwater use* covers how stock, domestic and garden use is administered across the state.

The plan area is part of the *Rights in Water and Irrigation Exemption and Repeal (Section 26C) Order 2001* and the amended version in 2007 (*Rights in Water and Irrigation Exemption (Section 26C) Order 2007*). As a result of this exemption order, licensing for bore construction and the take of water drawn from the watertable aquifer is not required for uses under Clause 4 below (5C and 26B (3–6)) (see Box 6). For all other purposes a licence must be issued. The following information is extracted from the original *Rights in Water and Irrigation Exemption and Repeal (Section 26C) Order 2001*. The exemption order applies to all proclaimed groundwater areas in the plan area. For the complete extract visit the State Law Publisher website <www.slp.wa.gov.au>.

Exemptions from Sections 5C and 26B (3) to (6) (Clause 3)

Sections 5C and 26B (3) to (6) of the *Rights in Water and Irrigation Act 1914* do not apply in relation to a non-artesian well if:

- the only water that can be taken from the well is from the watertable aquifer
- water taken from the well is used only in accordance with Clause 4.

Use of water (Clause 4)

1 Water taken from a well referred to in Clause 3 may be used for:

- a fire fighting
- b watering cattle or other stock, other than those being raised under intensive conditions as defined in s. 21(4) of the Act
- c watering an area of lawn or garden that does not exceed 0.2 hectare, subject to subclauses (2) and (3)
- d other ordinary domestic uses.

2 A lawn or garden is not to be watered by use of a sprinkler at any time during the hours of 9 am to 6 pm. Watering is restricted to three days per week.

Subclause (2) does not apply in respect of a lawn for a period of 28 days from when the lawn was planted. In this instance the times must be registered with the Department of Water (1800 508 885 and select option 2 or call the Waterwise Helpline on 13 10 39).

If groundwater is extracted for private drinking water supplies, it is advisable to filter, treat and test the water according to public health advice available from the Department of Health, Water Quality branch. The Department of Water also provides guidance for drinking water in its water quality protection notes <www.water.wa.gov.au> Waterways health > water quality.

The *Australian Drinking Water Guidelines 2004* (Australian Government 2004) and the *Australian Fresh and Marine Water Quality Guidelines* (ANZECC & ARMCANZ 2000) also provide information on relevant drinking-water quality criteria.

Action 19 – Provide information to groundwater users on how to operate under a *Rights in Water and Irrigation Act 1914* trading environment.

Box 6: Definitions for stock, domestic and garden exemptions in the plan area

Watertable aquifer: For the purposes of the 2001 exemption order the watertable aquifer is considered to be the Superficial, Surficial and fractured rock aquifers in the plan area.

This interpretation has been adopted to ensure continued management of regionally confined aquifers which may outcrop at the surface in localised areas where there is no confining layer (or no overlying Superficial or Surficial sediment). Consequently, domestic bores drawing water from the Leederville or Yarragadee aquifers where they are shallow or close to the surface require a licence.

Domestic: Ordinary domestic use for a residence (house).

Stock: Any domesticated animal raised under non-intensive conditions.

Intensive conditions means conditions in which the cattle or stock are confined to an area smaller than that required for grazing under normal conditions and are usually fed by hand or by mechanical means, (Section 21(4)) *Rights in Water and Irrigation Act 1914*).

The department uses benchmarks from the Department of Agriculture and Food Western Australia to determine the volume of water required for stock watering purposes.

Garden: Irrigation of gardens < 2000 m^2 associated with a domestic residence.

5.2 Management zones

Management zones have been established in the plan area to cater for specific water resource management issues (Figure 12). To address these issues local area policies have been developed (Table 7). These additional policies apply to new licence applications (including licence renewals and trades) in areas which have management zones. They allow for stringent protection, investigation or monitoring on a local scale. Water use in some areas is restricted to protect the resource from further abstraction and to manage potential impacts on dependent systems and the water resource (particularly the recharge areas and connected systems).

Table 7
Management zones – description and justification

No.	Description	Aquifer	Justification and risk or impact
1	Scott coastal plain wetlands – including Lake Jasper	Superficial	Minimise impacts to high value groundwater-dependent ecological and social values. Minimise the potential impact of declining water levels (abstraction) from underlying aquifers and connected systems.
2	Bunbury west subarea	Yarragadee and Superficial	Manage the connected Superficial and underlying unconfined Yarragadee aquifers from increased abstraction. Manage the impacts of increased urban development and concentration of domestic bores.
3	Water quality issues for the Swan coastal plain (north of Bunbury) and Kemerton Industrial Park	Superficial	Minimise current salt recycling and watertable aquifer quality (nutrients and potential ASS). Minimise current impacts to watertable levels. Restrict potential nutrient and pollution impacts on the watertable aquifer.
4	Jindong agricultural area	Leederville	Manage the current local impacts associated with concentration of draw points in the Leederville Aquifer (water level decline). Reduce abstraction (to allow for aquifer recovery) and encourage spread of draw points (location and depth).
5	Known areas of groundwater baseflow from regional aquifers	Leederville and Yarragadee	Manage groundwater abstraction to avoid impact to groundwater baseflow in the Capel and Brunswick rivers.
6	Swan coastal plain wetlands – including Stirling wetlands, Vasse–Wonnerup estuary, wetlands north of Bunbury	Superficial and underlying connected aquifer	Minimise impacts on groundwater-dependent ecological systems from abstraction in the underlying aquifers and connected systems. Control the decrease in runoff and changes to drainage from agricultural and urban activities. Control abstraction to minimise impacts on social and ecological sites from regional and local abstraction.
7	Buffer zone area defined by ASS plume from Beenup mine site	Leederville, Lesueur Sandstone and Superficial	Manage the existing ASS impact in the Leederville and Lesueur Sandstone aquifers. Increase the monitoring to minimise movement of the ASS plume into surface water systems (Scott River and Hardy Inlet). Reduce abstraction to minimise water level changes and exposure of ASS.
8	Discharge and recharge (groundwater) areas of the Blackwood River (including Hut pool, Poison Gully, St John Brook) and Yarragadee outcrop area (recharge zone)	Leederville and Yarragadee	Minimise the potential impacts from regional abstraction which may affect water levels in the recharge area and cause changes to the discharge zones on the Blackwood River and tributaries, affecting associated GDE. Minimise the potential impact from local abstraction close to the river (downstream of Darradup). Increase monitoring and minimise impacts on the recharge zone from regional abstraction.

Table 7
Management zones – description and justification

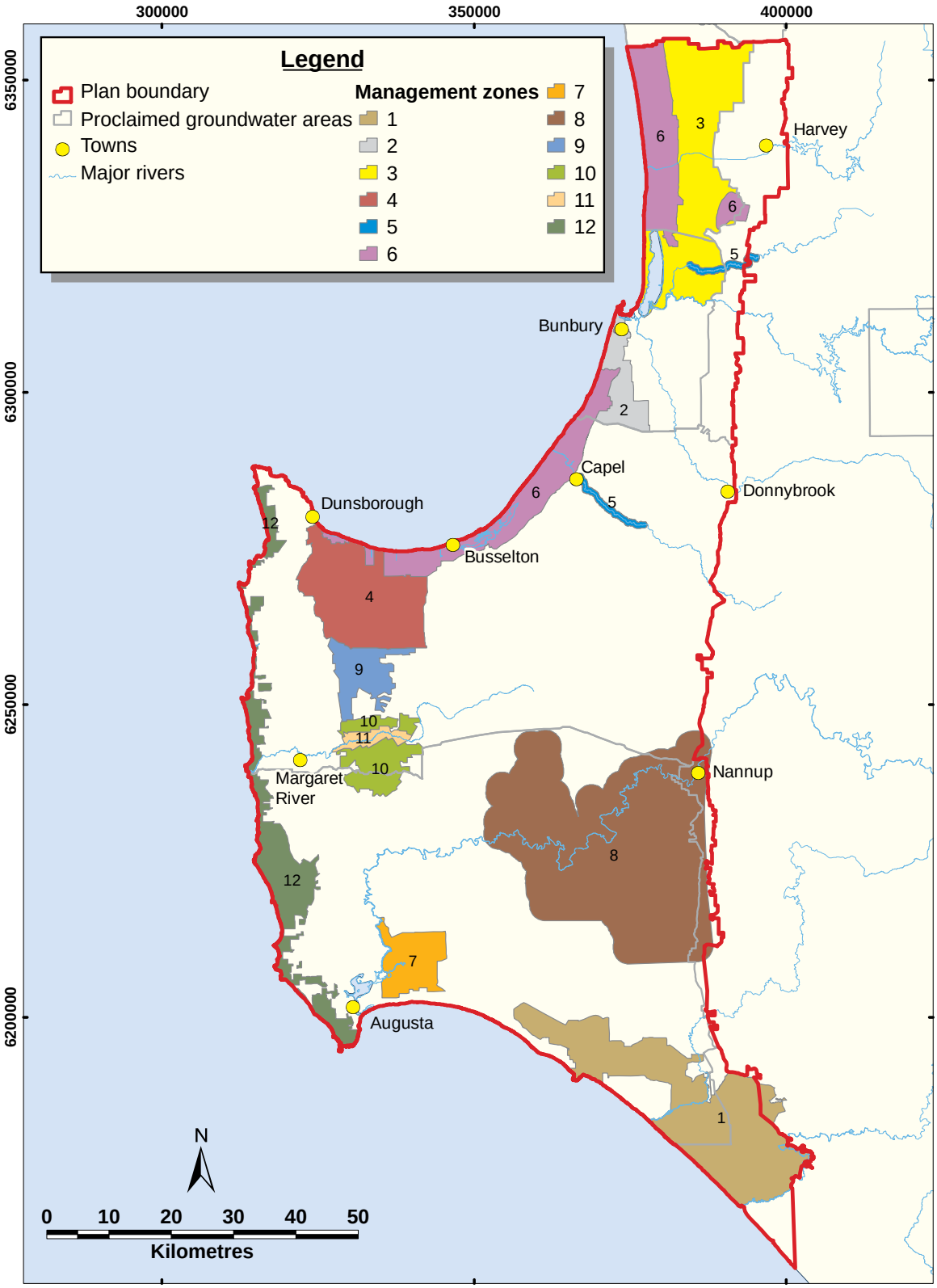
No.	Description	Aquifer	Justification and risk or impact
9	Cowaramup viticultural area	Leederville	Manage groundwater abstraction to minimise cumulative impacts on the Dunsborough–Vasse subarea.
10	Recharge area for Leederville Aquifer on the Vasse shelf	Leederville	Manage abstraction in the recharge area of the Leederville Aquifer.
11	Margaret River pools	Leederville and connected surface water	Restrict the abstraction of groundwater and surface water from the Margaret River pools to maintain river base flows in summer and support the ecology.
12	Cave systems and coastal vegetation	Fractured rock and Surficial	Manage the potential connected cave and vegetation communities dependent on groundwater from fractured rock and Surficial sediments.

How to use the management zone tables

The following tables (Tables 9–11) are used by licensing officers in the licence assessment process to determine where additional policies apply to minimise the risks associated with a new groundwater licence. The local area policies are to be used in conjunction with the policies detailed in Section 5.1. The reasons why we have developed the management zones and the aquifers corresponding to each zone are detailed in Table 7. The groundwater area, subarea, aquifer and which local area policies apply are detailed in Table 8 which contains the local area policies. Table 10 is a reproduction of Table 1, page 11, from *Statewide policy no. 19 – Hydrogeological reporting associated with a groundwater well licence* (DoW 2007b) which is applied to every new groundwater licence application.

The process for applying the local area policies to the management zones is:

- Determine if a new application is within a management zone (Table 7 and Figure 12).
- Determine which local area policies apply based on the management zone (Table 8) and where additional points (see Table 10) are required for the assessment process described in Table 7.
- Apply the local area policies (Table 9) to the assessment of the new licence application (conditions and restrictions).
- Inform the applicant of what is required to complete the assessment of the licence and if any additional conditions will be part of their licence (if issued) to ensure they are aware of the increased restrictions on groundwater use in their area.
- Complete the licence assessment.



Locality map

Government of Western Australia
Department of Water

This map is a product of the Dept of Water, Water Resource Use Division and was printed on 13/02/2009.

While the department has made all reasonable efforts to ensure the accuracy of this data, the department accepts no responsibility for any inaccuracies and persons relying on this data do so at their own risk.

Sources

DoW acknowledges the following datasets and their Custodians in the production of this map:

Western Australia Towns – DLI – 2003
Global Map Data Australia 1M – GA – 30/06/2001
Plan_Boundary – DoW – 05/11/2007
Hydrography, Linear (Hierarchy) – DoW – 08/06/2006
RIWI Act, Groundwater Areas – DoW – 06/03/2008
Water_Management_Zones – DoW – 2009

Datum & projection information

Vertical datum: AHD
Horizontal datum:GDA 94
Projection: MGA 94 Zone 50

Project information

Requestee: Rebecca Palandri
Map Author: Brenden Huntley
Filename J:\pp\wa\C2106\0007\mxd\0900213_SWGA_Management_Zones.mxd
Date: 13/02/2009

Figure 12
Management zones

Table 8
Management zones – location and additional requirements

No.	Groundwater area and subarea		Aquifer	Additional assessment and local area policy*
1	Blackwood	Scott and Jasper	Superficial	+2 points to c Policies **m-ii, iv** and **v** apply
2	Bunbury	Bunbury West	Yarragadee and Superficial	+2 point to c Policies **m-ii, iii, iv** and **vi** apply
3	Bunbury and South West Coastal	Australind, Myalup, Harvey, Wellesley, Lake Preston North and South, Kemerton Industrial Park North and South	Superficial	+2 points to c Policies **m-ii, iv, v** and **ix** (< 250 m from an existing production bore) apply
4	Busselton–Capel	Dunsborough–Vasse	Leederville	+2 points to c Policies **m-i, iii** (minimum depth 40 m below ground level), **iv** and **ix** (2 km from existing production bore)
5	Bunbury and Busselton–Capel	Busselton–Capel and Australind/Kemerton South	Leederville and Yarragadee	Policies **m-iii, iv** and **x** apply
6	Bunbury, South West Coastal and Busselton–Capel	Dunsborough–Vasse, Busselton–Capel, Bunbury West, Australind, Myalup, Kemerton North and South, Lake Preston North and South.	Superficial and underlying connected aquifer	Policies **m-ii, iii, iv**, and **vi** apply
7	Blackwood	Beenup and Rosa–Beenup	Leederville, Lesueur and Superficial	+2 points to c Policies **m-i, ii, iii** and **vii** (Leederville, Lesueur and Superficial) apply
8	Busselton–Capel and Blackwood	Blackwood Plateau North and South	Leederville and Yarragadee	Policies **m-iv** and **vi** apply in areas of freehold land
9	Busselton–Capel	Cowaramup	Leederville	Policies **m-iii** (minimum depth 60 m below ground level), **viii** (max allocation per draw point is 100 000 kL/yr) and **ix** (3 km from exiting active production bore) apply
10	Busselton–Capel and Blackwood	Cowaramup and Rosa	Leederville	+3 to d for applications > 1 km from the Cowaramup/ Dunsborough–Vasse subarea boundary Policies **m-iii** (minimum depth of 40 m below ground level), **viii** (max allocation per draw point is 100 000 kL/yr) and **ix** (3 km from existing active production bore) apply

Table 8
Management zones – location and additional requirements

No.	Groundwater area and subarea		Aquifer	Additional assessment and local area policy*
11	Busselton–Capel	Cowaramup and Cape to Cape North	Leederville and connected surface water	Policies **m-i, iv** and **vii** (Leederville) apply
12	Busselton–Capel and Blackwood	Cape to Cape North and South	Fractured rock and Surficial	Policies **m-iv, vii** (Surficial and fractured rock aquifers) and **ix** (500 m of management zone boundary)

*Note: See Table 9 for management zone policy and Table 10 for scoring details (a, b, c etc).

Table 9
Management zone local area policies for the taking and use of groundwater in the plan area

No.	Local area policy
m-i	All licensed water use must be metered.
m-ii	Water quality measurements, as specified by the department, must be undertaken annually (such as salinity, pH, acidity) for the watertable aquifer at the end of summer (March/April) for licensed entitlements > 250 000 kL/yr.
m-iii	Minimum bore and screen depth for new applications to construct a production bore apply. The depth will be stated on the 26D licence conditions.
m-iv	If the cumulative impacts of abstraction cause environmental water criteria to be breached a hierarchy of management responses will be triggered.*
m-v	A maximum allocation of 4000 kL/ha applies where the application meets the normal licensing requirements and policies in the plan (Section 5.1).
m-vi	Any application for a domestic and/or garden bore licence, not exempt from licensing, will only be granted a maximum entitlement of 500 kL/yr in this area.
m-vii	No additional allocations will be granted within the management zone. No new bores or excavations are to be constructed into the specified aquifer, other than for exempt use, replacement bores, monitoring purposes or remediation.
m-viii	Maximum allocation amount per draw point applies (specified on 5C licence), with compulsory pump test required to determine the yield of the bore (specified on 26D licence) before 5C licence can be issued.
m-ix	Minimum spatial distance requirements apply between new and existing production bore/s (as specified on 26D the licence to construct) for all new licence applications.
m-x	Maximum groundwater allocation of 10 000 kL/yr for a draw point within 500 m of a defined water course applies to all new groundwater licences.

* Note: The maximum extent of these management responses is to enforce alternative pumping regimes and possibly reduce licence entitlements. See Del Borrello 2008 for more information.

How to use Table 10

Table 10 is used in conjunction with the policies in the plan and the local area policies (Table 8 and 9) in the licence assessment process for a new application. In particular Table 10 is applied where additional points are specified in Table 8.

When applying the additional assessment and local area policy requirements (last column in Table 8) the additional points described correspond to the appropriate column in Table 10 as shown below.

a	volume
b	allocation
c	potential impacts on other users
d	potential impacts on groundwater-dependent ecosystems
e	salinity

Add the points together to give the score = (a + b + c + d + e.). The score sets the level of hydrogeological assessment required to complete the approval process for the licence application.

The level of hydrogeological assessment and the point score which applies to each level are detailed below.

0 to 7 points	Generally no assessment required, unless other knowledge of risks indicates that H1 level assessment (desktop Hydrogeological assessment) is warranted.
8 to 12 points	H1 level assessment (desktop Hydrogeological assessment). However, low volume applications with low risk of impacts may not warrant an assessment. These cases can be discussed with the Regional Hydrogeologist.
12 to 18 points	H2 level assessment (basic Hydrogeological assessment including installation and testing of investigation bores).
> 19 points	H3 level assessment (detailed Hydrogeological assessment including installation and testing of investigation bores, and a groundwater model).

For the complete methodology on how to use Table 10 and the point assignment system please refer to *Statewide policy no. 19 – Hydrogeological reporting associated with a groundwater well licence*.

Table 10
Decision table for hydrogeological assessments

Volume requested kL/yr	Level of allocation	Potential for unacceptable impacts		Existing salinity* mg/L
		Other users	GDE	
<10 000 (0 points)	0–30% (0 points)	Impacts unlikely (0 points)	Impacts unlikely (0 points)	Fresh <500 (4 points)
50 000 (2 points)	30-70% (1 points)	Impacts possible (2 points)	Impacts possible (2 points)	Marginal TDS 501–1500 (3 points)
50 001–250 000 (4 points)	70–100% (3 points)	Impacts likely (5 points)	Impacts likely (5 points)	Brackish TDS 1501–5 000 (2 points)
250 001–500 000 (6 points)	>100% (5 points)			Saline TDS 5000–50 000 (1 points)
500 001–1 000 000 (8 points)				Hypersaline >50 000 (0 points)
1 000 001–2 500 000 (15 points)				
>2 500 000 (20 points)				
Points assigned = a	Points assigned = b	Points assigned = c	Points assigned = d	Points assigned = e

*Salinity categories obtained from National Land and Water Resources Audit (NLWRA 2000).

Chapter six

Monitoring the groundwater resources

6.1 Program description

The objective of the monitoring program for the South West groundwater areas is to ensure that the department manages the water resource for consumptive use while protecting the dependent social, cultural and ecological values.

The supporting document *South West groundwater areas monitoring program* (DoW 2008g) outlines the department's commitments to monitoring, including water levels, water quality and environmental criteria sites across the plan area.

The monitoring program for the South West groundwater areas consists of sub-programs addressing the four most important aspects of water management (Table 11). The program is part of the plan implementation and will provide a measure of the success of the South West groundwater areas plan in achieving the stated water resources objectives. This monitoring and review is a core component of adaptive management and should trigger management action when unforeseen or unacceptable impacts begin to occur.

The monitoring program is summarised in Table 11 and the monitoring network for each sub-program is detailed in Appendix D.

Table 11
Summary of the monitoring program and activities

Monitoring sub-program	Activities		Location and frequency
	Monitoring	Investigations	
Groundwater levels	Monitor groundwater levels	Compliance with licences and effects on other groundwater users Aquifer connectivity Impacts of climate change	The groundwater level network (~450 bores) is measured six times per year to capture maximum and minimum water levels
Groundwater quality	Parameters measured include groundwater salinity, nutrients, industrial contaminants and acidity arising from the oxidation of acid sulfate soils	Seawater intrusion	Water quality network and program being developed
Connected surface water and groundwater systems	Surface water levels and flow measurement Groundwater monitoring bores have been installed specifically to measure water levels at some connected systems The groundwater level monitoring network is utilised to measure groundwater levels near connected systems	Hydrological and inter-connectivity investigations Eco-hydrological studies Ecological water requirements studies	Blackwood, Capel and Donnelly rivers have annual flow snapshots and long-term investigations Margaret River pools have continuous water level measurement Lake Jasper has continuous water level measurement Ecological water requirements investigations being conducted for Margaret, Brunswick Capel and Blackwood rivers, and Wilyabrup and Cowaramup brooks
Environmental water provisions	Groundwater-dependent vegetation condition monitoring Groundwater level measurement at representative groundwater-dependent vegetation sites	Triggers and responses for groundwater levels have been established for some representative groundwater-dependent ecosystems Eco-hydrological and hydrogeological investigations Ecological water requirements studies for vegetation	Monthly groundwater measurement and annual vegetation condition monitoring at 39 sites across the South West groundwater areas Ecological water requirements determined for 24 of these sites Continuous time series data collected at some of these sites by data loggers

6.2 Program review

The department will review each of the sub-programs annually. This review will include analysis and reporting of measured results (as detailed in Chapter 7) and assessment of the success of the monitoring sub-program against its objectives.

Groundwater levels

The groundwater levels sub-program will be reviewed annually by assessing trends, particularly in areas with high levels of abstraction and areas where the risk of intrusion of the seawater interface is known to be high, such as around Bunbury and Busselton. Adverse water levels and trends will trigger a management response to investigate the measured results and management actions as required (Appendix B).

It is recommended in the monitoring program that groundwater level data should be comprehensively analysed every four years for groundwater level trends and their correlations with abstraction, climate and interconnectivity.

The first statistical analysis of groundwater level trends and response to abstraction and climate in the South West groundwater areas has been completed by an external consultant on behalf of the department and the report (Golder, 2008) is available on the department's website.

Groundwater quality

The groundwater quality sub-program (DoW 2008g) will be reviewed annually for each of the groundwater quality parameters. It must be emphasised that with the development of the new groundwater quality program the department is in a phase of collecting and consolidating baseline data. Management trigger levels will be based on best available knowledge and data will be reviewed against those levels. Better informed triggers will be developed over the longer term as data is analysed and the dynamics of the groundwater systems are better understood. Management responses will be developed in parallel with this increased knowledge.

Connected surface water and groundwater systems investigations

The connected systems sub-program has been initiated with the proposed investigations centred on the Blackwood, Donnelly, Capel and Margaret rivers. The annual review of this information will focus on the consolidation of sampling points, collation and assessment of data, and the longer term development of management triggers based on the synthesis of the data collected.

Environmental water provisions

The relationship between groundwater levels and vegetation condition at representative groundwater-dependent ecosystems is reviewed as part of the environmental water provisions sub-program. This is important both for the long-term understanding of the environmental condition in response to climate change and regional use as well as providing information for the triggers and response process (see below and Del Borrello 2008).

To better understand water level trends at groundwater-dependent ecosystem sites the department is currently defining a control site network to measure groundwater levels where human impacts are minimal, so the impacts of reduced recharge can be assessed. The department will use this network to better understand the specific impacts of pumping and other activities separate from the natural pattern of groundwater level decline due to reduced rainfall.

Triggers and responses for the environmental water provisions program

This section identifies specific triggers and responses for managing particular high-value groundwater-dependent ecosystems in the three groundwater areas. While only a few sites have been identified in this plan due to the scarcity of site-specific data, the number of sites will be expanded over the next 12 months and

again over the next two to four years prior to the implementation of the statutory groundwater allocation plan.

While there will never be the capacity to monitor every groundwater-dependent ecosystem in the Bunbury, Busselton–Capel and Blackwood groundwater areas, the trigger-response sites may also act as indicators for other sites in similar geomorphological settings.

As part of the groundwater allocation planning process, a variety of studies have been conducted over the past five years to:

- identify potential groundwater-dependent ecosystems
- ascertain which potential groundwater-dependent ecosystems may be at risk of impact due to drawdowns caused by current and future groundwater pumping at the local or regional scale
- select a number of high conservation value groundwater-dependent ecosystem reference sites for a local-scale evaluation of risk using the available numerical groundwater models
- determine the ecological water requirements of some of the groundwater-dependent ecosystem reference sites in high and lower risk areas through more detailed, site-specific investigation.

This work (to December 2006) has been summarised in Hyde 2006, *A summary of investigations into the determination of ecological water requirements for the South West groundwater areas*.

The work to determine ecological water requirements at reference sites, which initially involves shallow drilling, establishment of vegetation-transects and ongoing measurement of water levels, water quality (in some instances) and vegetation condition, is being carried out in stages across the three groundwater areas. Because of this, the quantity of available data varies from site to site depending on when monitoring began.

Whether quantitative management triggers could be established at a site in time for the release of the groundwater allocation plan was therefore determined by the amount of baseline data on vegetation condition and the prevailing water regime that was available at each site.

While recommended triggers and responses have been set for a limited number of sites, monitoring and evaluation is continuing at other reference sites where shallow bores and vegetation transects have been established (see DoW 2008f). Work is continuing on establishing bores and vegetation transects at sites where this has not yet been done, such as near the upper Margaret River, Reedia wetlands in the lower Blackwood River area and in the western Scott coastal plain.

Action 20

- **a** Measure the groundwater levels of regional monitoring bores (Figures D1 and D2) six times per year to capture maximum and minimum water levels.
- **b** Annually review and report on water level measurement data in areas of high groundwater abstraction and in areas of seawater intrusion risk along the coast.
- **c** Annually review and report on data collected through investigations and during regular water quality measurements.
- **d** Annually review water quality management triggers and responses.
- **e** Annually collate, analyse and report on data collected from investigations of connected systems.
- **f** Analyse water levels on a monthly basis over the summer period and vegetation condition on an annual basis following spring measurements at groundwater-dependent ecosystem sites where management triggers and responses have been established.
- **g** Analyse water levels at all other representative groundwater-dependent ecosystem sites in March–April each year and review vegetation condition annually following spring measurements.

Action 21 – Store groundwater monitoring data in appropriate databases and review data on a regular basis.

Where a decline in ecological health and/or a notable decline in groundwater levels occurs at any of the monitored groundwater-dependent ecosystems where a trigger and response has not been specified, the cause will be investigated and a suitable management response will be developed for that site. This information will be included in the department's annual reporting associated with the groundwater allocation plan.

The sites where there is a management trigger and response framework that applies to this plan are listed in Table 12 and 13. The frameworks are shown in Appendix B. Specific triggers and responses will be developed for other representative groundwater-dependent ecosystem sites in the following two to three years when sufficient measurement data is collected at those locations. Full details of the management trigger and response framework are available in the supporting document *Management triggers and responses for groundwater-dependent ecosystems in the South West groundwater areas,* (Del Borrello 2008).

Table 12
Established sites with EWR criteria and where management trigger and response frameworks apply

Site name	Groundwater area	Subarea	Monitoring bore name	EWR trigger m AHD
Kemerton	Bunbury	Australind	EW1	8.05
Hay Park	Bunbury	Bunbury West	EW2	2.73
Harewoods Rd	Bunbury	Bunbury West	EW5	5.72
Ludlow Rail Reserve	Busselton–Capel	Busselton–Capel	BN10S	7.50
Ruabon Reserve	Busselton–Capel	Busselton–Capel	EW10	17.16
Ambergate Reserve	Busselton–Capel	Busselton–Capel	BN32S	16.85
Poison Gully	Blackwood	Blackwood Plateau–South	Poison Gully-wetland	30.47
Reedia	Blackwood	Blackwood Plateau–South	BP64B	23.73
Black Point Rd	Blackwood	Jasper	Black Point Rd	42.69
Lake Jasper	Blackwood	Jasper	EW8	38.50

Table 13
Groundwater-dependent surface water sites where site-specific management trigger and response frameworks should be applied

Site name	Groundwater area	Subarea	Management trigger
Blackwood River – Darradup Gauging Station	Blackwood	Blackwood Plateau–South	Flow below historical minimum during months of summer baseflow
Blackwood River – Hut Pool Gauging Station	Blackwood	Blackwood Plateau–South	Flow below historical minimum during months of summer baseflow

Chapter seven

Implementing and reviewing the plan

Part of ensuring that this plan is successful in managing the water resources of the South West groundwater areas is setting out the detail of how the plan will be implemented, evaluated and reviewed.

7.1 Implementing the plan

Actions required to implement this plan are summarised in Table 14. Actions to inform future planning have also been identified and are summarised in Table 15.

7.2 Evaluating the implementation of the plan

To identify whether the management strategies identified in the plan are working to achieve the objectives of the plan, the department will release an annual evaluation statement. The statement will identify:

- the status of water use
- the status of all actions required by the plan
- performance against the plan objectives, including resource performance (as per Table 2)
- strategies for meeting the plan objectives (Table 2)
- groundwater-dependent triggers that have been activated and the effectiveness of these responses (as per Del Borrello 2008)
- any minor changes to the plan.

The performance indicators and associated strategies by which the plan's objectives will be evaluated are detailed in Chapter 3. Throughout the life of the plan the monitoring of the water resources and environmental sites as well as changes to management considerations (such as increased demands) will alter the responses. Where the response changes it will be reported on in the annual evaluation statement.

Action 22 – Produce and release the public evaluation statement.

7.3 Reviewing the plan

A review of the plan will normally take place every seven years or earlier if the evaluation statement recommends a review. In this case the plan will be reviewed in 2011. The plan will also undergo an early review if it is not meeting its objectives or if new information becomes available.

Western Australia is currently updating and reviewing its legislation for the state's water resources. Any significant changes in legislation that may affect this plan, will trigger a review of the plan, including replacing the plan with a statutory water management plan. Any changes to the plan will only be introduced where there is a demonstrable need and after extensive consultation with stakeholders and the wider community in the South West.

Table 14
Actions for implementing the plan

Action		Responsibility*	Trigger or timeline
Monitoring Program			
Implement the department's groundwater monitoring program.	Action 4	South West Region	As scheduled
Monitoring data management			
Store groundwater monitoring data into the department's systems.	Action 21	Measurement and Water Information	As scheduled
Resource assessment			
Complete resource assessment reports which summarise resource trends including water levels, quality, connected systems and GDE sites.	Action 2, and Action 20 (a–e)	Water Resource Assessment and Water Allocation Planning	Annually
Communication and evaluation statement			
Produce and release the public evaluation statement.	Action 22	South West Region	Annually
Develop a program for stakeholder consultation for the review of this plan.	Action 15	South West Region	2010
Licensing			
Carry out water use surveys in priority areas and report on outcomes at a subarea level.	Action 10	South West Region	Annually (Note: priority areas identified in the annual evaluation statement)
Carry out compliance surveys in fully allocated and over-allocated resources.	Action 17	South West Region	As required.
Initiate processes to recoup unused water entitlements.	Action 18	South West Region	As required.
Review public water supply licences and reserved water requirements.	Action 11	South West Region	First quarter 2009
Licensing support			
Investigate the potential for short term temporary licensed entitlements from the public water supply reserve.	Action 12	Water Licensing	Second quarter 2009
Provide information to groundwater users on how to operate under a *Rights in Water and Irrigation Act 1914* trading environment.	Action 19	Water Licensing	Third quarter 2009
Policy support			
Develop a guideline to clarify current policy and arrangements for managing water use by plantations under the current legislation.	Action 14	Water Allocation Planning and Strategic Policy and Planning	Guideline due second quarter 2009, Policy due last quarter 2009.
Investigate potential self-management model for use in the future.	Action 13	Water Allocation Planning and South West Region	First quarter 2009.
Systems			
Create a GIS-based decision support tool that identifies groundwater-dependent features and their associated cultural and social values to assist ongoing management.	Action 8	Water Allocation Planning	2010

*Department of Water branch that is responsible for implementing the actions in the plan.

7.4 Future planning

While this plan sets out our water use management approach for the next few years we are also looking ahead and working towards improving and eventually replacing it. Throughout this report, there are a number of recommended actions that will contribute to future planning in the South West groundwater areas and these are summarised in Table 15. As with the actions for the plan implementation, the progress against them will be reported each year in the evaluation statement.

The department has received funding (Box 7) from the Australian Government's Water for the Future – Water Smart Australia program for a number of projects that will build on existing information and contribute to the development and review of this plan over the next three years.

Box 7: Further research and investigations (Australian Government's Water for the Future – Water Smart Australia program)

There has been a large amount of research and investigation of the South West groundwater system by the Department of Water (and by the Water Corporation as part of the proposal to access Yarragadee water for the Integrated Water Supply Scheme). The Yarragadee investigations included extensive drilling in the state forest area of the South West groundwater areas and other work to identify the potential impacts of abstracting 45 GL/yr from the aquifer.

Understanding of the entire groundwater system, not just the Yarragadee Aquifer, is important for groundwater management. It is also important to note that, with the costs of single exploratory bores reaching into the hundreds of thousands of dollars, it is difficult to gain adequate knowledge. The department, with funding assistance from the Water Smart Australia Program, will spend more than $7 million dollars for innovative research and investigation to allow the best possible management of this complex groundwater system.

This work will improve this plan and culminate in the development of a statutory water management plan for allocating water, by 2011. Further advice and progress on this work will be provided through the annual evaluation statement described in Section 7.2.

Table 15
Actions for future planning

Action		Responsibility	Timeline
Resource assessment and investigation			
Conduct drilling investigations into hydrogeology to inform revision of the model and the next plan.	Action 1	Water resource assessment	Commences second quarter 2009 Reports due first quarter 2010
Update and review groundwater model including surface water interactions.	Action 3	Water resource assessment	Due by first quarter 2010
Environmental management			
Conduct investigations into key groundwater-dependent ecosystem sites for aquifer connectivity and response to abstraction and climate change.	Action 6	Water allocation planning	Investigations due for completion second quarter 2009 Report due fourth quarter 2009
Report on current understanding of passive acid sulfate soil risk to inform the review of the plan and monitoring program.	Action 5	Water resource assessment	Investigations due for completion mid 2009 Report due late 2010.
Further define the groundwater-dependent social and cultural values.	Action 7	Water allocation planning	Due by second quarter 2009
Determine water requirements of groundwater-dependent cultural and social values.	Action 9	Water allocation planning	Dependent on completion of Action 7
Licensing support			
Review allocation limits with improved information.	Action 16	Water allocation planning	To be started in 2011
Communications			
Develop a program for stakeholder consultation for the review of this plan.	Action 15	South West Region	To be started in 2010

Appendices

South West groundwater areas allocation plan

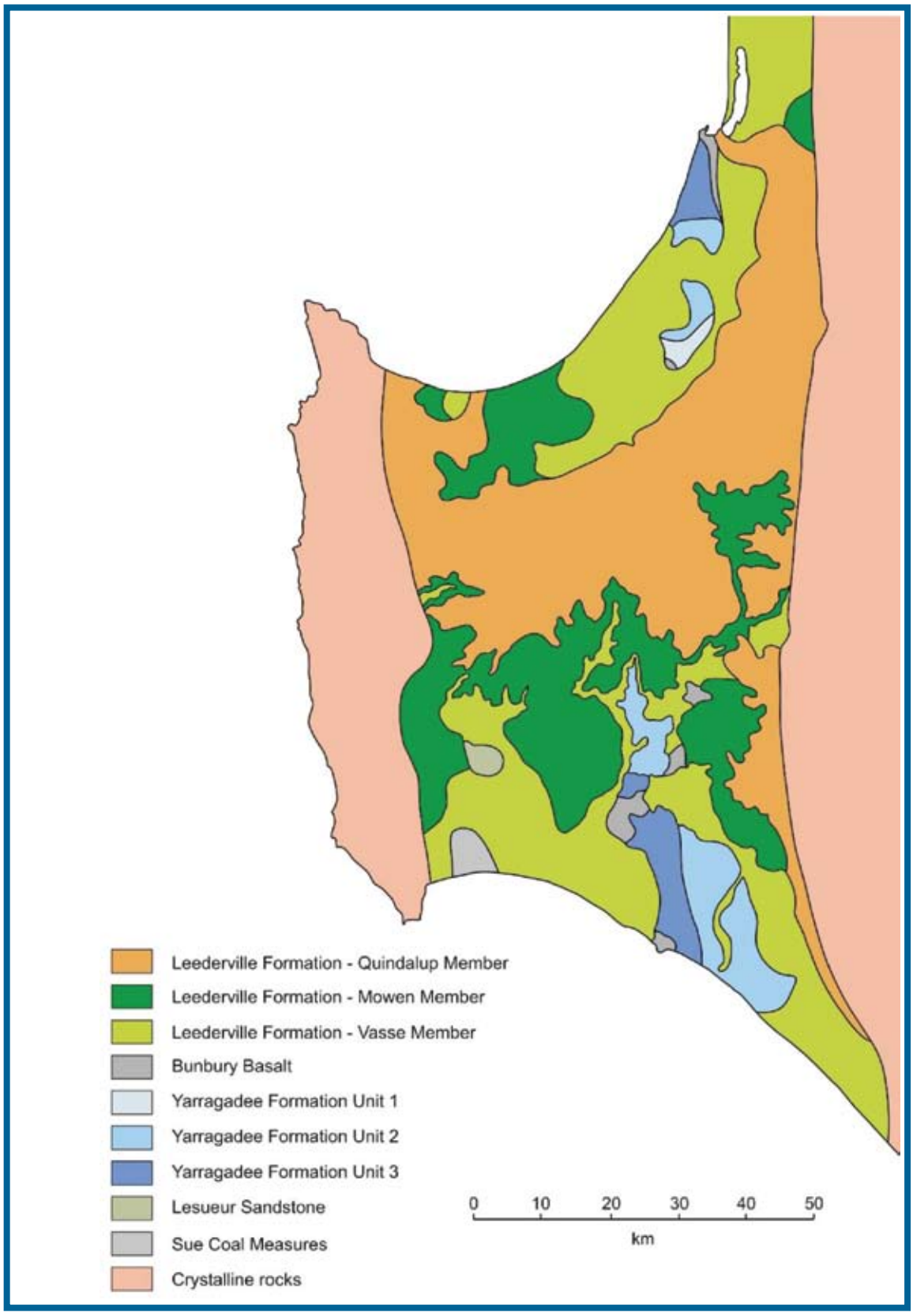


Figure A1
Geological diagram showing distribution of Leederville Formation and older formations

A Appendix
Hydrogeological and geological diagrams and maps

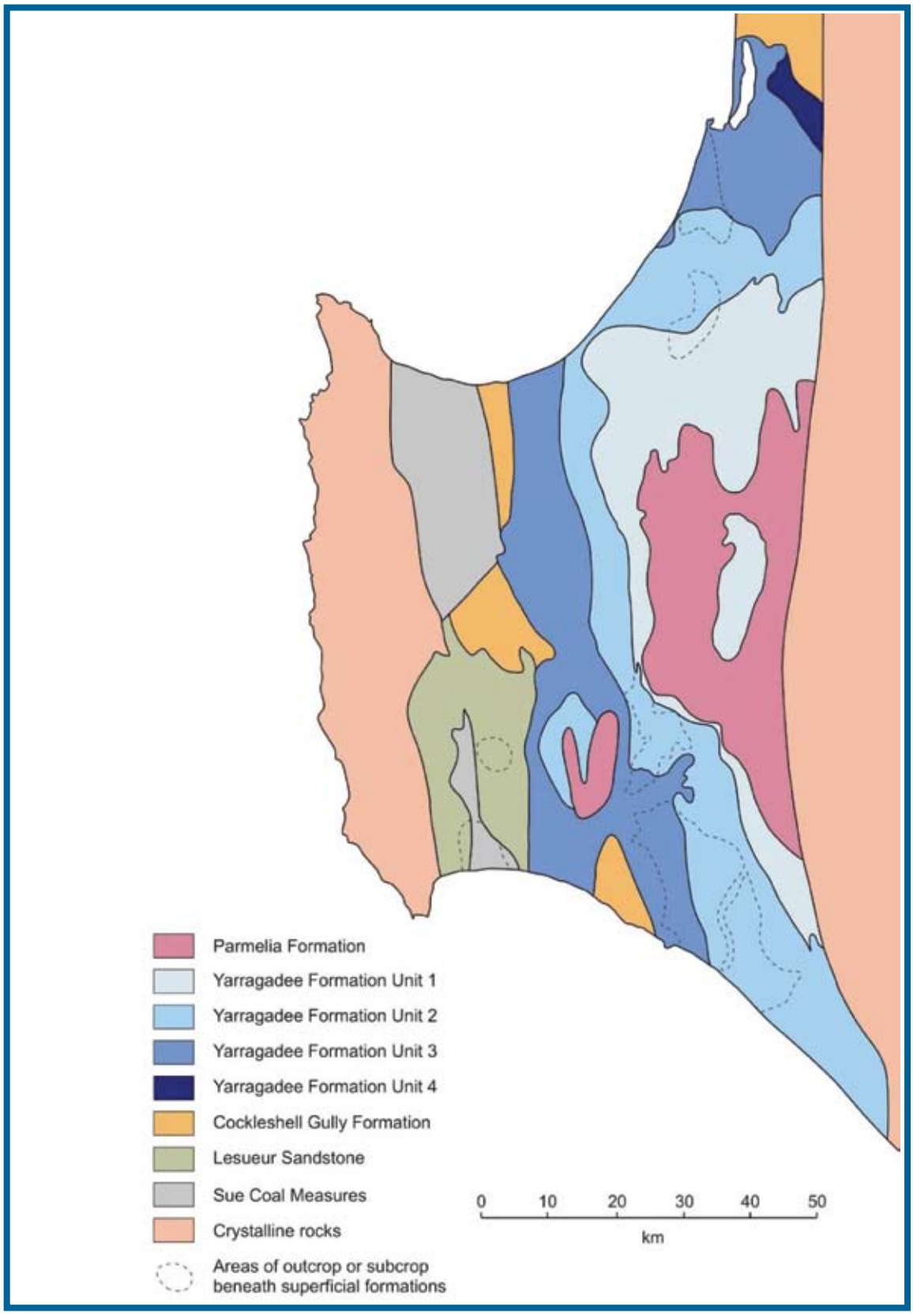


Figure A2
Geological diagram showing units beneath the Bunbury Basalt and Leederville Formation

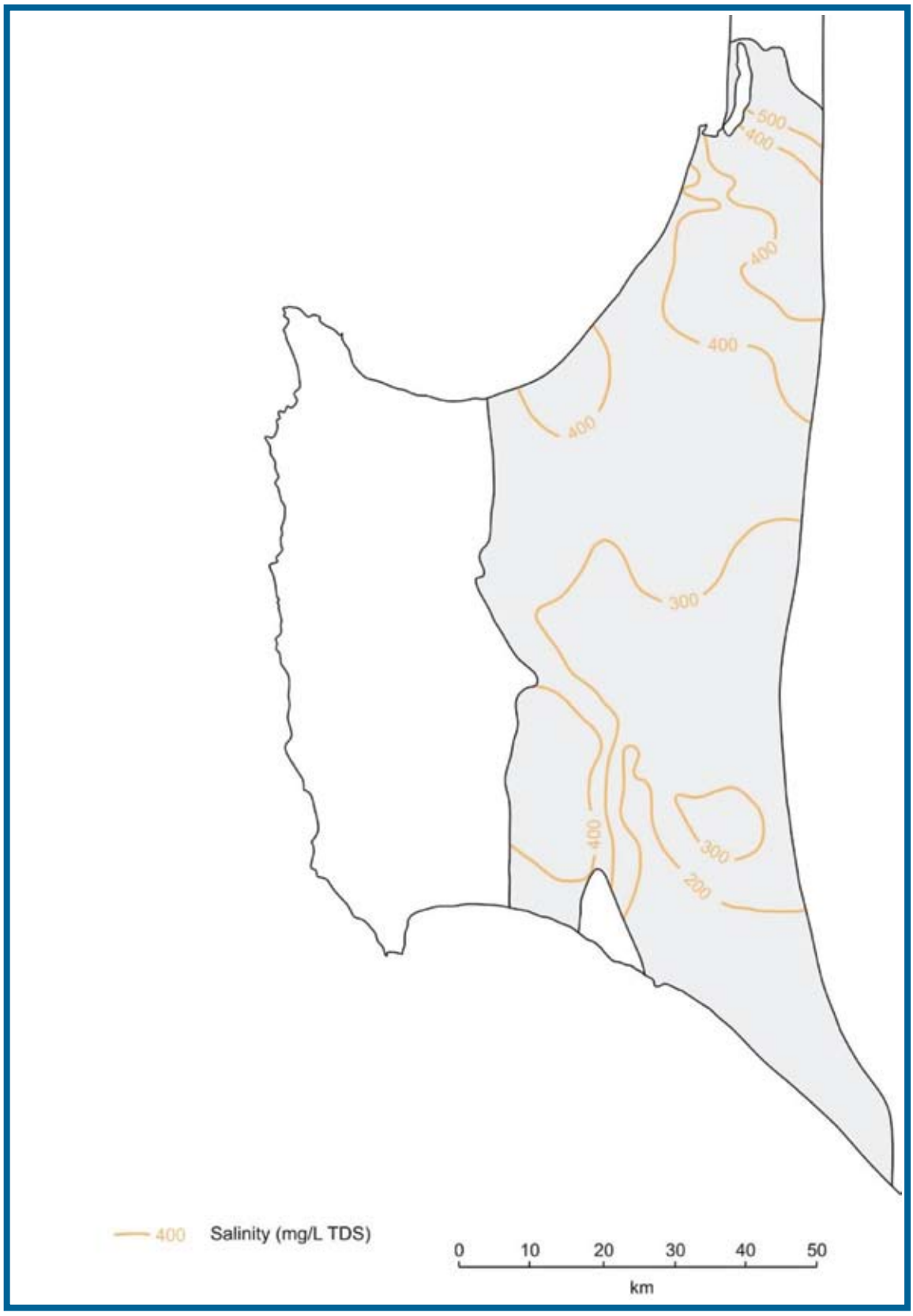


Figure A3
Diagram of groundwater salinity in the Yarragadee Aquifer

A Appendix
Hydrogeological and geological diagrams and maps

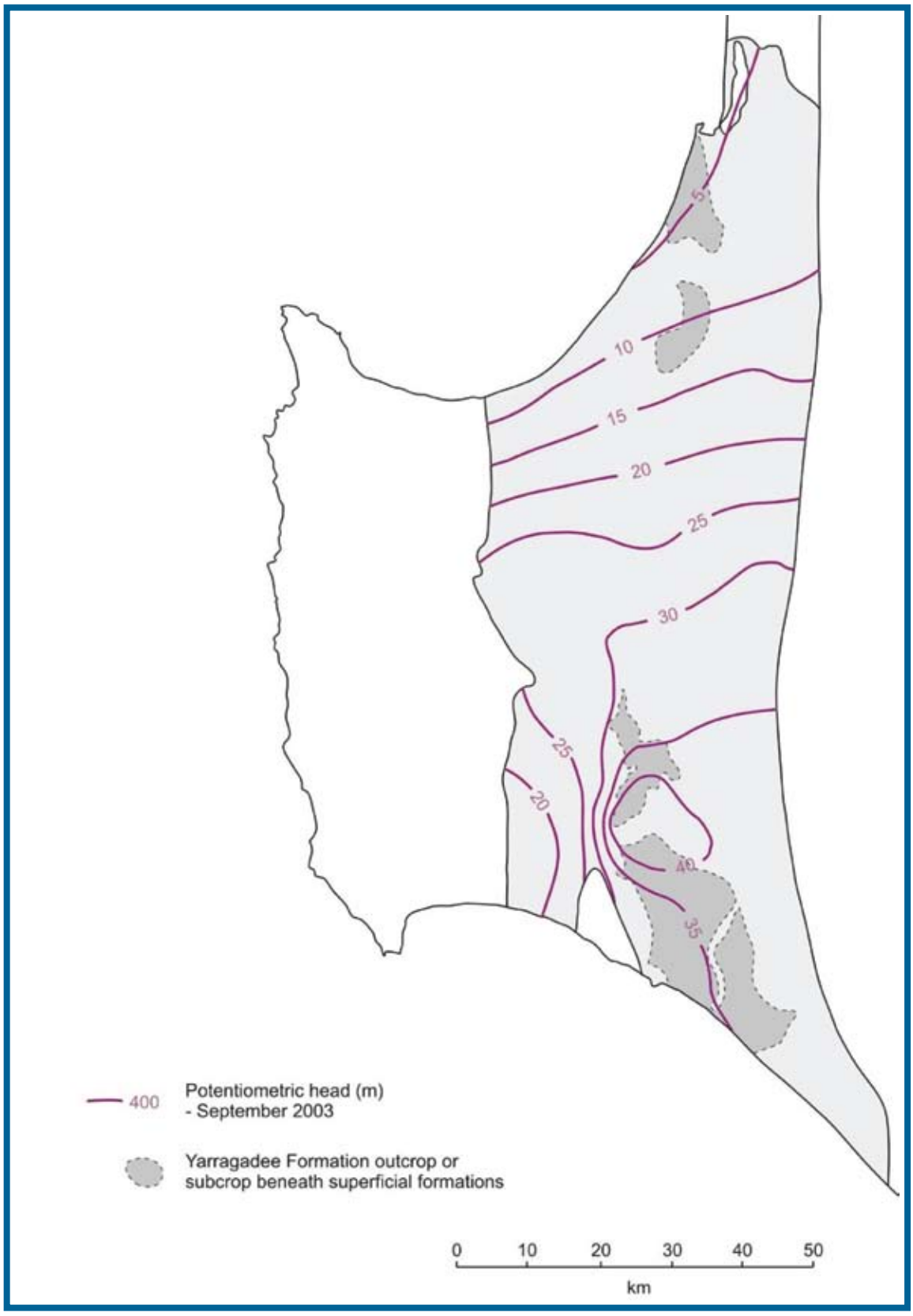


Figure A4
Diagram of the potentiometric head in Yarragadee Aquifer

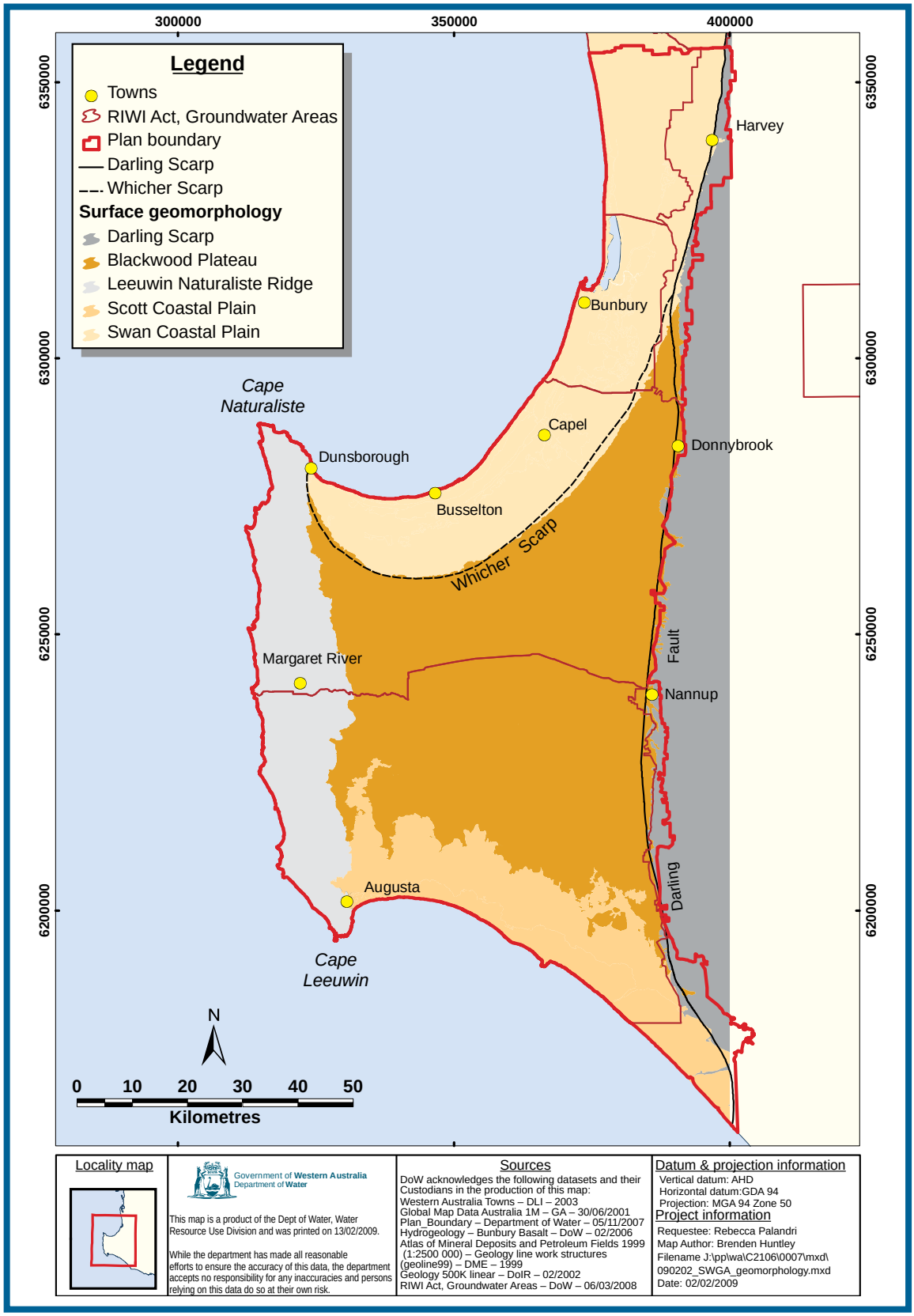


Figure A5
Surface geology of the plan area

A Appendix
Hydrogeological and geological diagrams and maps

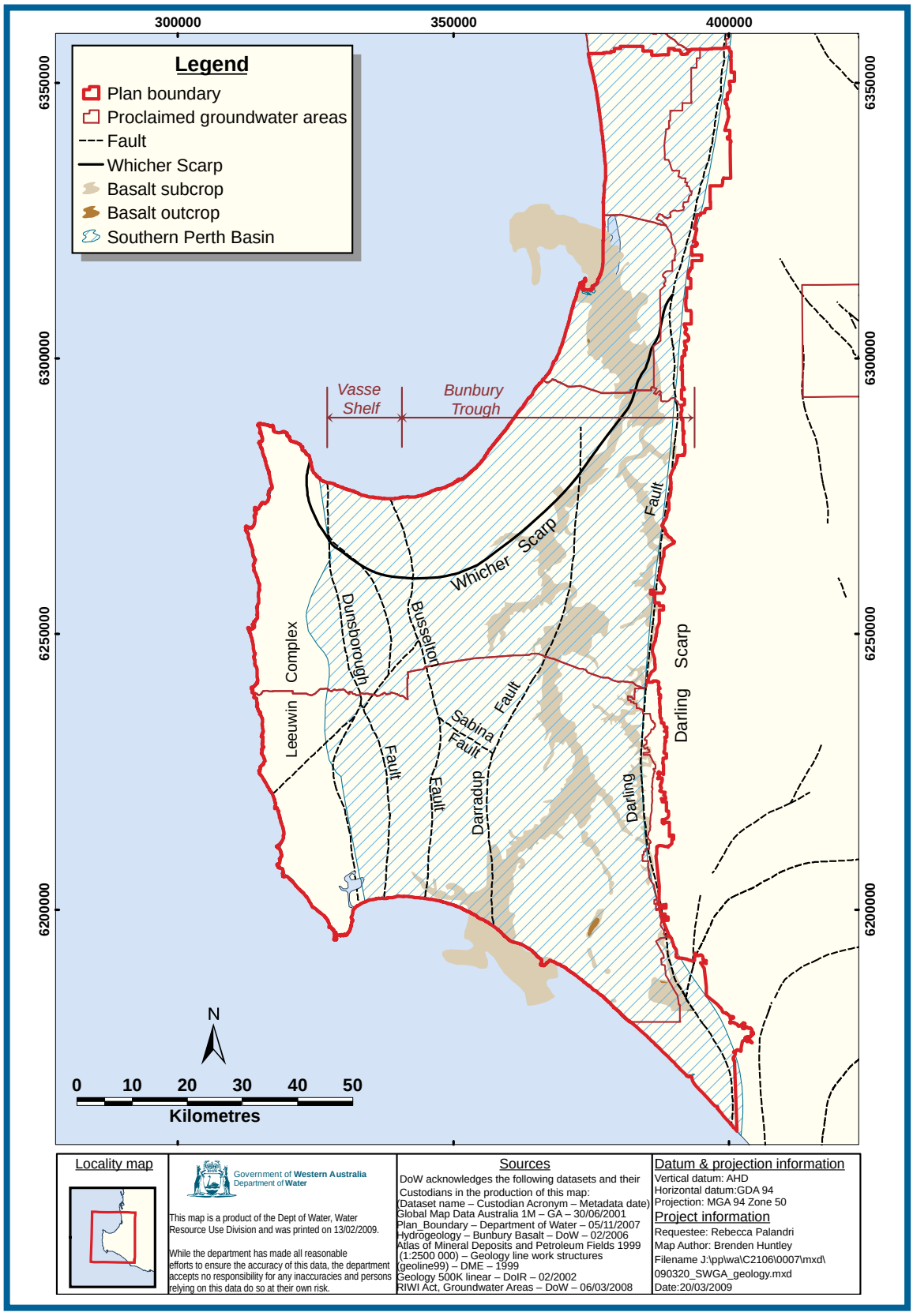


Figure A6
Geology of the plan area

Adverse trend detected in water table monitoring at GDE reference site:
- breach of EWR trigger; or
- declining trend (>0.1m/yr); or
- sudden large drop or rise in water level (>50% larger than normal seasonal variation)

Review vegetation condition monitoring data (note: vegetation condition may need re-checking if some time has passed since it was last monitored)

Has there been a decline in vegetation condition?

Yes

Vegetation may have been affected by a change in water availability.

Review data to determine if vegetation may also be affected by water quality changes or a biological factor such as insect attack or dieback.

1 If the decline in condition is severe, notify DEC if appropriate (TEC etc). Develop temporary artificial maintenance scheme if feasible e.g. drippers, sprinkler system, manual watering.
2 If EWR trigger has not been breached, the trigger should be reviewed.
3 If a review of water level monitoring data shows that abstraction is the cause of the water level change, develop plan to reduce abstraction and implement if decline in vegetation condition is significant.
4 Undertake review of allocation limits for implementation in next planning period.
5 Report findings.
6 Continue to monitor vegetation. Monitoring may need to be increased to include a summer/autumn round.

No

Water regime change may not be significant enough to affect vegetation

OR

There may be a lag between water regime change and decline in vegetation condtion

Continue to monitor vegetation. Monitoring may need to be increased to include a summer/autumn round

Review water level monitoring data

Conduct analyses to identify cause of water regime change e.g.
- Check water level trend against climate reference sites
- statistical analysis of hydrographs,
- investigation of surrounding abstraction,
- review of local water level monitoring data

Is abstraction causing decline in water levels?

Yes

1 Conduct licence compliance checks.
2 Investigate whether reductions in local abstraction or changes to abstraction practices will result in reduced impact at GDE reference site.
Develop plan to reduce abstraction and implement if change to water regime is severe or a breach of EWR trigger coincides with a significant decline in vegetation condition.
3 Undertake review of allocation limits for implementation in next planning period.
4 Report actions.

No

Are land use changes or drainage causing changes to water regime?

Yes

1 Work with relevant agencies/ land owners to develop strategies to halt land use impacts and restore site hydrology.

No

Is climate causing water regime changes?

Yes

1 Notify DEC if appropriate (TEC etc.).
2 Report findings.
3 Continue monitoring as per normal. Summer/autumn monitoring of vegetation may be necessary if water regime changes are significant or EWR trigger has been breached.
4 Review EWR prior to implementation of statutory plan.

Review water quality monitoring data

Has there been a change in water quality beyond trigger levels?

Yes

1 Notify DEC if appropriate.
2 Conduct investigation to determine cause of water quality change.
3 Develop plan to effect improvement in water quality and return water quality to within trigger limits (these actions may be related to actions to stabilise water regime).

No

Continue monitoring.

Review vegetation condition and water level monitoring data

No monitoring data

Is site in ASS or salt water interface risk zone?

Yes

Conduct water quality sampling

No

Review vegetation and water level monitoring data

Figure B1
Management trigger and response framework — wetland vegetation

← return to contents

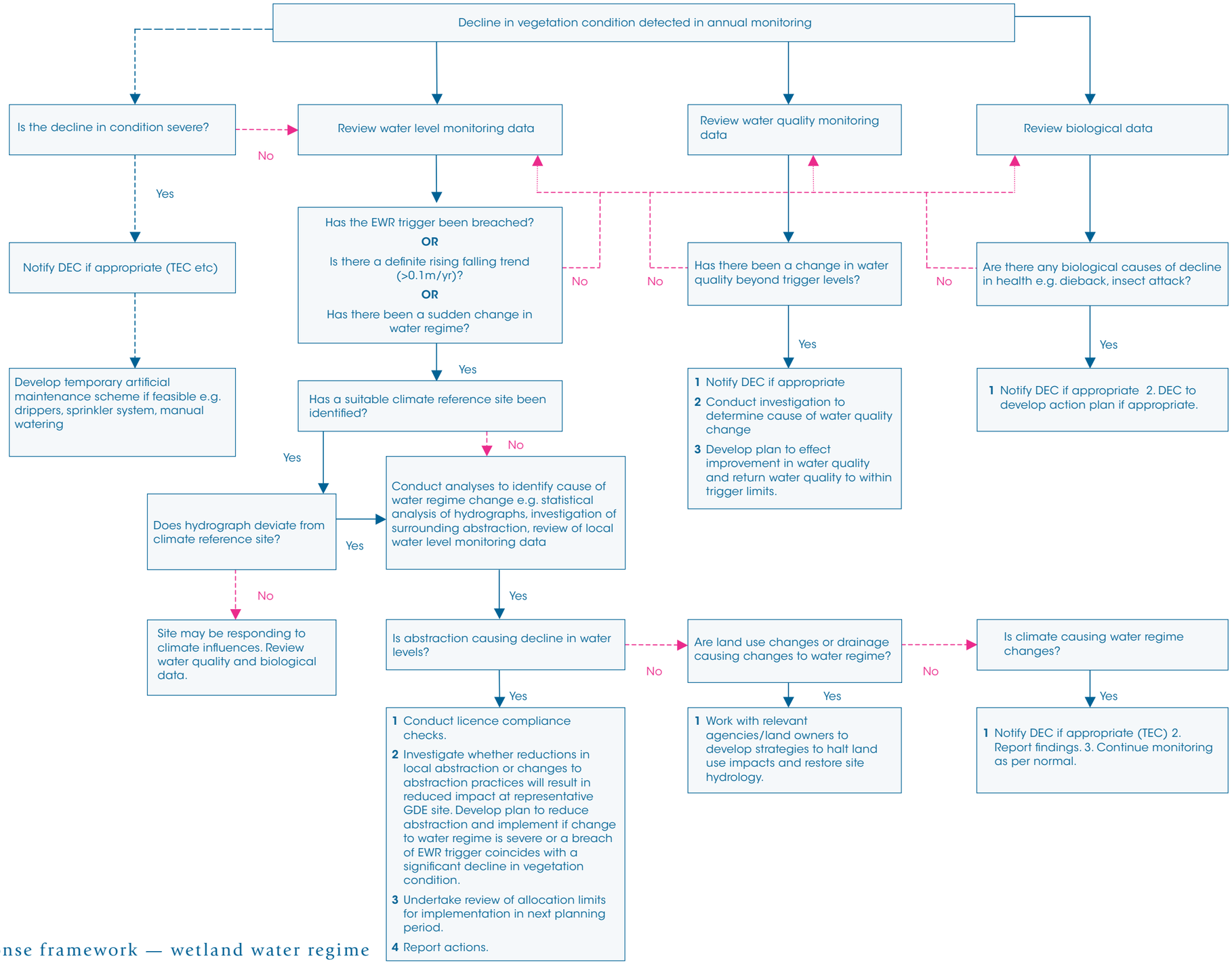


Figure B2
Management trigger and response framework — wetland water regime

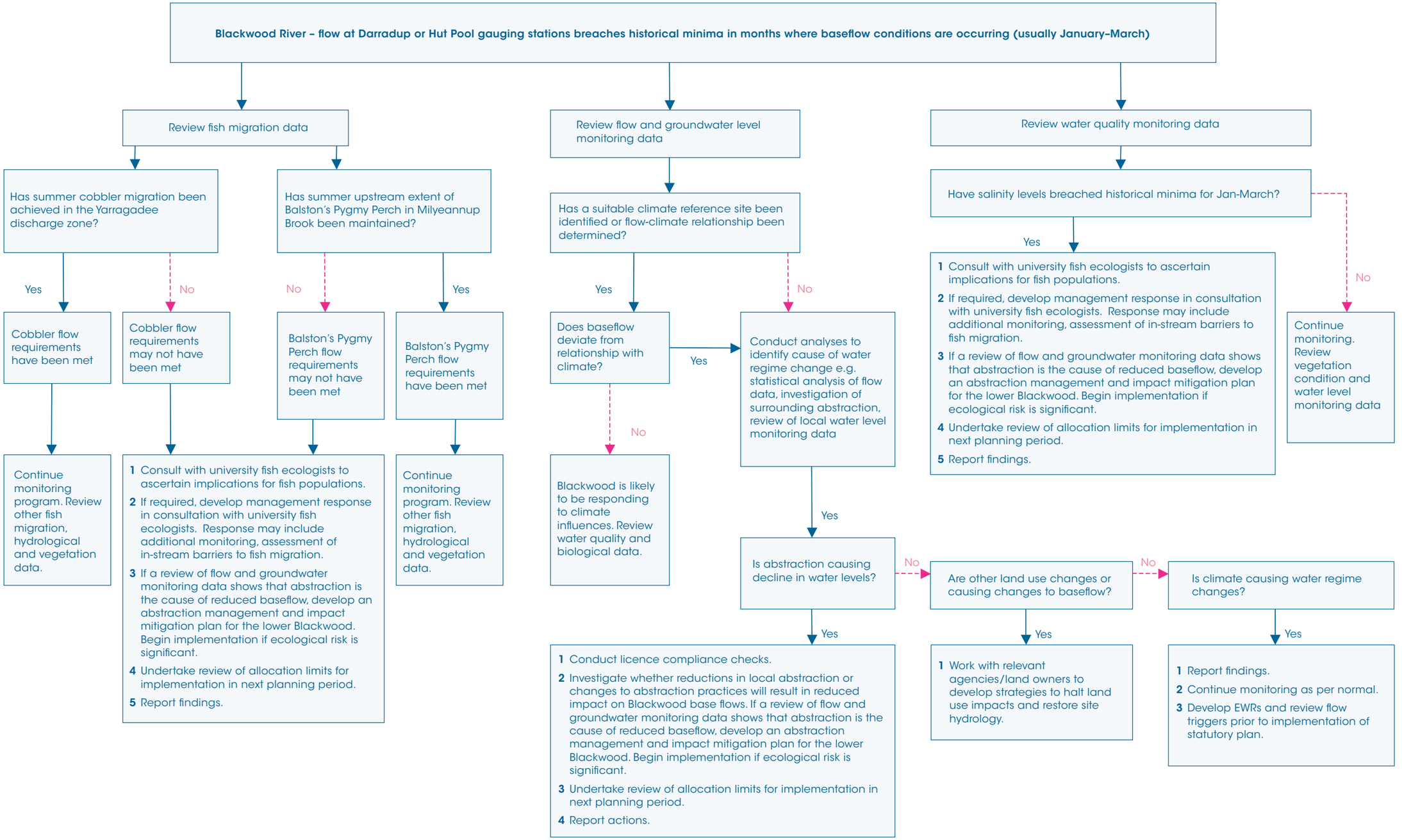


Figure B3
Framework for management of lower Blackwood River baseflow

← return to contents

C Appendix
Water service providers

The Busselton Water Board formed in 1906 is the licensed water service provider that supplies potable water for domestic consumption and town needs, for light industry, commerce and other civil purposes for the shire of Busselton. The Busselton Water Board does not provide water for irrigation or large industrial purposes and their activities are constrained to the urban areas around the town of Busselton. Water use by the Busselton Water Board has increased with population growth in Busselton and its surrounding suburbs.

The Bunbury Water Board (Aqwest) formed in 1906 is the licensed water service provider that supplies potable water for domestic consumption and town needs (except for Pelican Point), for light industry, commerce and other civil purposes for the City of Bunbury. Water use by Aqwest has increased with population growth in Bunbury and its surrounding suburbs.

The Water Corporation (WC) is the water services provider for the remaining town and small hamlets in the South West region. They also supply water for domestic consumption and town needs, for light industry, commerce and other civil purposes. All Water Corporation supplies are restricted to the town sites, and they do not supply water to rural properties in the region. The Water Corporation supplies many growing town sites and localities with potable water from a variety of sources including groundwater and surface water.

Table C1
Town water supply licensed allocations for the plan area (GL/yr) (2009)

Town*	Service provider and site name		Licensed entitlement	Water resource
Busselton	Busselton Water Board		1.00	Leederville
			17.00	Yarragadee
Bunbury	Aqwest		4.40	Yarragadee
			4.80	Yarragadee
Capel	WC	Capel well field	0.40	Yarragadee
Donnybrook		Donnybrook well field	0.45	Leederville
Dunsborough, Quindalup, Yallingup		Quindalup well field	0.70	Sue Coal Measures
			0.75	Leederville
Margaret River		Margaret River and Ten Mile Brook	1.00	Margaret River–Ten Mile Brook
Peppermint Grove Beach		Peppermint Grove Beach well field	0.11	Yarragadee
Australind		Australind well field	0.01	Yarragadee
			3.30	Leederville
Boyanup		Boyanup well field	0.33	Yarragadee
Dalyellup		Dalyellup well field	1.00	Yarragadee
Dardanup		Dardanup well field	0.08	Leederville
Eaton		Eaton well field	1.50	Yarragadee
Brunswick Junction		Australind well field	0.56	Leederville
Augusta		Fisher Road well field	0.32	Lesueur Sandstone
		Leeuwin spring	0.12	unproclaimed
Total			37.83	

*Myalup and Binningup are now supplied by the IWSS.

D Appendix
Monitoring network

Table D1
Monitoring network (number of bores in aquifer)

Area	Groundwater monitoring line (monitoring line code)	Aquifer							
		Superficial	Leederville	Yarragadee	Cockleshell Gully	Lesueur Sandstone	Sue Coal Measures	Parmelia	Total
Swan coastal plain	Bunbury Shallow (BY)	18	12	18	0	0	0	0	48
	Busselton Shallow (BN)	28	64	6	0	0	2	0	100
	Donnybrook (DNB)	0	8	0	0	0	0	0	8
	Picton (PL)	0	1	4	0	0	0	0	5
	Yalgorup Lakes (Y)	1	0	0	0	0	0	0	1
	Lake Clifton (D, E, F & G)	34	0	0	0	0	0	0	34
	Harvey Shallow (HS)*	55	0	0	0	0	0	0	55
	Binningup Line (BLP)	0	3	0	3	0	0	0	6
	Kemerton (KE)	17	4	0	4	0	0	0	4
	Boyanup (BL)	1	4	9	2	0	0	0	16
	Quindalup** (Q)	0	3	10	0	0	0	0	13
	Leschenault Peninsula	0	2	0	0	0	0	0	2
	Jindong Project (BJM)	0	4	3	0	0	0	0	7
	Capel Farms (JMB)	0	3	0	0	0	0	0	3
	Environmental Water (EW) bores***	16	0	0	0	0	0	0	16
Blackwood Plateau	Cowaramup (CL)	0	10	10	3	0	4	0	27
	Cowaramup (CW)	0	14	0	0	0	0	0	14
	Karridale (KL)	0	4	11	2	7	0	0	24
	Environmental Water Bores***	10	0	0	0	0	0	0	10
	Blackwood Plateau (BP)	0	73	66	1	1	0	6	147
Scott coastal plain	Scott Coastal** (SC)	16	18	21	0	7	0	0	62
	Environmental Water bores***	8	0	0	0	0	0	0	8
Total		204	227	158	15	15	6	6	631

*Only the HS line bores located in the plan area. **These bore lines also have monitoring bores on the Blackwood Plateau.

****EW bores not illustrated in Figure D1, but see Figure 7 and Figure 8.*

Table D2
Groundwater-dependent reference sites for wetland vegetation

Site name	Area	Location	EWR defined	Monthly groundwater level monitoring	Annual vegetation monitoring
Jangardup Rd	Scott coastal plain	E: 0376796 N: 6195468	Yes	Yes	Yes
Black point Rd		E: 0374002 N: 6202371	Yes	Yes	Yes
Pneumonia Rd		E: 0382524 N: 6198769	Yes	Yes	Yes
Black Point Rd –Fouracres Rd		E: 0374674 N: 6202796	Yes	Yes	Yes
Black Point Rd – base of dunes		E: 0367690 N: 6196827	Yes	Yes	Yes
Black Point Rd – dunes		E: 0367277 N: 6196134	Yes	Yes	Yes
Lake Jasper – East		E: 0379693 N: 6190381	Yes	Yes	Yes
Lake Jasper – South		E: 0377320 N: 6190681	Yes	Yes	Yes
Darradup Rd –west	Blackwood Plateau	E: 0383500 N: 6215756	Yes	Yes	Yes
Darradup Rd east – wetland		E: 0384052 N: 6215595	Yes	Yes	Yes
Longbottom Rd – wetland		E: 0371576 N: 6229310	Yes	Yes	Yes
Poison Gully		E: 0366689 N: 6223558	Yes	Yes	Yes
Brockman Hwy wetland		E: 0372353 N: 6228296	Yes	Yes	Yes
Stewart Rd Causeway		E: 0372104 N: 6212136	Yes	Yes	Yes

Table D2
Groundwater-dependent reference sites for wetland vegetation

Site name	Area	Location	EWR defined	Monthly groundwater level monitoring	Annual vegetation monitoring
Kemerton Buffer Zone	Swan coastal plain	E: 0384906 N: 6323330	Interim	Yes	Yes
Hay Park		E: 0373905 N: 6307073	Interim	Yes	Yes
Franklandia nature reserve		E: 0378756 N: 6300900	Interim	Yes	Yes
Manea Park		E: 0375526 N: 6305770	Interim	Yes	Yes
Harewoods Rd		E: 0372390 N: 6302405	Interim	Yes	Yes
Capel nature reserve		E: 0364622 N: 6283269	Interim	Yes	Yes
Spanish Settlers reserve		E: 0354893 N: 6267364	Interim	Yes	Yes
Locke nature reserve		E: 0336769 N: 6273503	Interim	Yes	Yes
Ruabon reserve		E: 0361191 N: 6276284	Interim	Yes	Yes
Vasse – Yallingup Siding		E: 0327163 N: 6272900	Interim	Yes	Yes
Taylor's nature reserve wetland		E: 0333217 N: 6263801	Interim	Yes	Yes
Ludlow Rail reserve		E: 0359580 N: 6280090	Interim	Yes	Yes
Tutunup		E: 0367915 N: 6273890	Interim	Yes	Yes
Ambergate reserve		E: 0344960 N: 6265815	Interim	Yes	Yes

Table D3
Groundwater-dependent reference sites for terrestrial vegetation

Site name	Area	Location	EWR defined	Monthly groundwater level monitoring	Annual vegetation monitoring
Black point Rd	Scott coastal plain	E: 0377818 N: 6205052	Yes	Yes	Yes
Black Point Rd – Fouracres Rd		E: 0374672 N: 6202799	Yes	Yes	Yes
Scott Rd		E: 0383669 N: 6189305	Yes	Yes	Yes
Jack Track		E: 0367274 N: 6206784	Yes	Yes	Yes
Darradup Rd east	Blackwood Plateau	E: 0384148 N: 6215590	Yes	Yes	Yes
Longbottom Rd		E: 0371558 N: 6229250	Yes	Yes	Yes
Brockman Hwy		E: 0372341 N: 6228259	Yes	Yes	Yes
Darradup Rd north		E: 0375826 N: 6219540	Yes	Yes	Yes
Stewart Rd		E: 0371387 N: 6212820	Yes	Yes	Yes
Poison Gully		E: 0366689 N: 6223558	Yes	Yes	Yes
Taylor's nature reserve	Swan coastal plain	E: 0333600 N: 6263170	Interim	Yes	Yes

D Appendix
Monitoring network

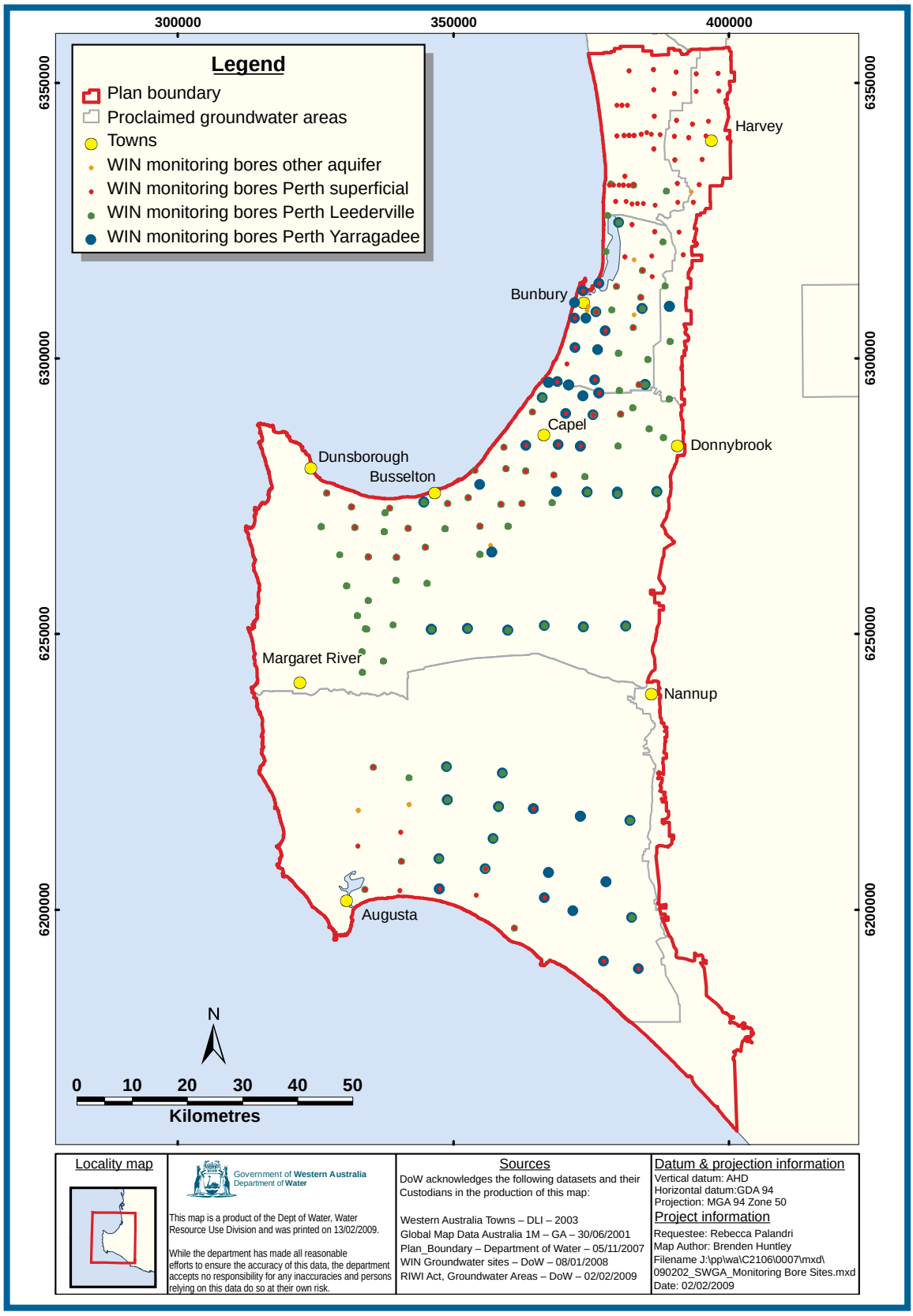


Figure D1
Location of the departmental regional monitoring bores and their aquifers

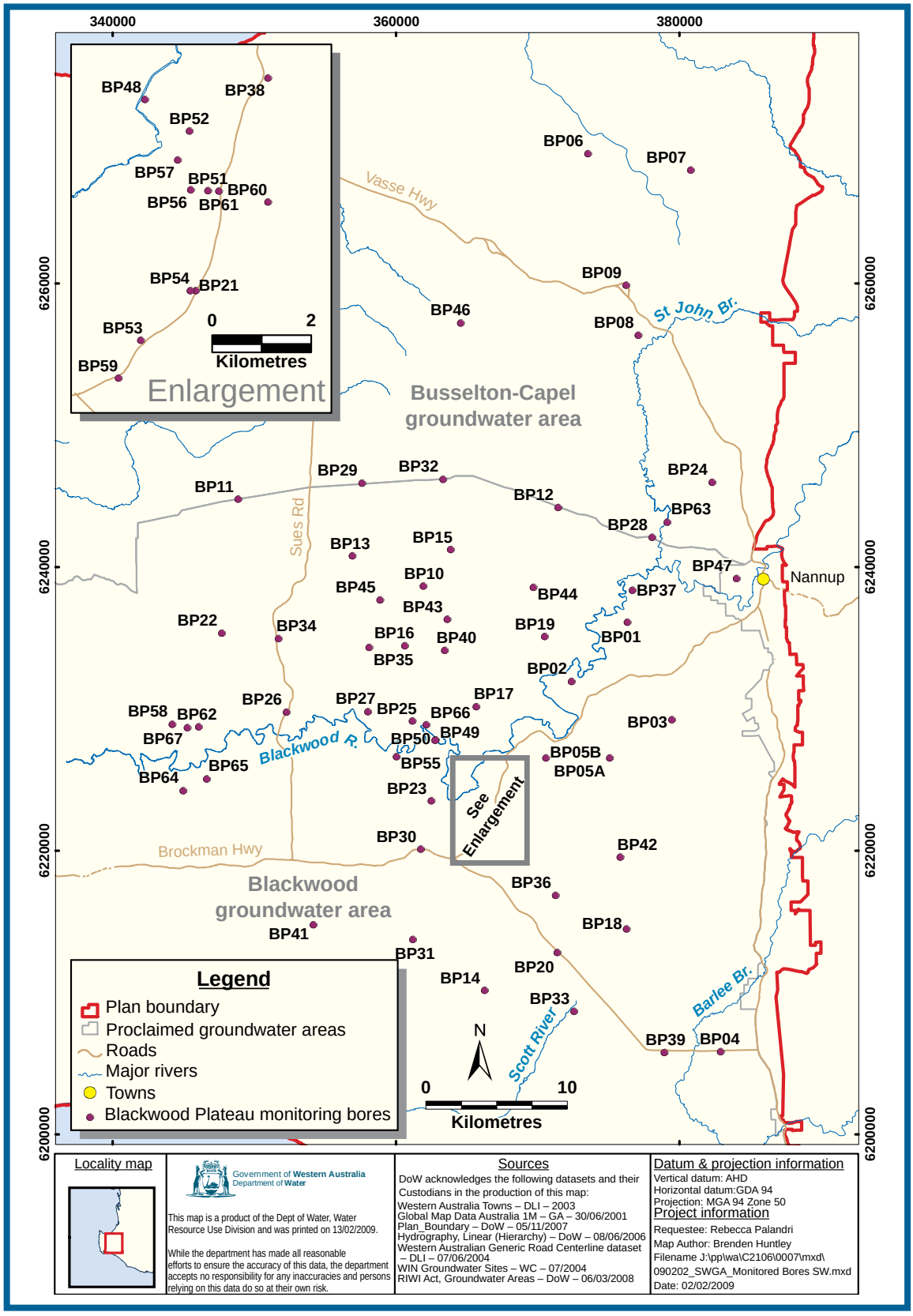


Figure D2
Blackwood Plateau monitoring bore series

Appendix E
Guidelines for assessing the potential risk of impact to groundwater dependent ecosystems

In most areas of the state, groundwater use must be licensed under the *Rights in Water and Irrigation Act, 1914* by the Department of Water (with the exceptions of some stock and domestic use).

Before a groundwater well licence is issued to an applicant, the department undertakes an assessment, including an evaluation of the potential impacts of taking the groundwater. On some occasions, the department requires additional information in order to make a more informed decision on the licence application. This may occur where:

- the volume of water requested is large
- the level of knowledge regarding the state of the groundwater source is limited
- the demand for accessing a particular groundwater resource is high
- the potential impacts of taking the water are considered significant.

In these cases, the licence applicant may be requested by the department to undertake a hydrogeological assessment, at their own cost, to determine the potential impacts of taking the groundwater. The requirements of this hydrogeological assessment are detailed in *Statewide policy no. 19 – Hydrogeological reporting associated with a groundwater well licence* (DoW 2007b).

When applicable the department will determine the level of assessment that is required, as follows:

- H1 – desktop hydrogeological assessment
- H2 – basic hydrogeological assessment including drilling and test pumping
- H3 – detailed hydrogeological assessment including drilling, test pumping and a groundwater model.

This appendix has been prepared as a supplement to Statewide policy no. 19 specifically for use in the South West groundwater areas. It has been prepared to provide guidance, in addition to that provided in the plan and *Statewide policy no 19*, to licence applicants on how to assess the potential effects on groundwater dependent ecosystems from their proposed water abstraction.

Groundwater-dependent ecosystems are ecosystems that rely at least in part on access to groundwater for survival. Groundwater-dependent ecosystems can be divided into six general types:

- wetlands – aquatic communities and fringing vegetation dependent on groundwater fed lakes and wetlands
- terrestrial vegetation – vegetation communities with seasonal or occasional dependence on groundwater
- river baseflow systems – riparian or aquatic ecosystems found along rivers or streams in which groundwater flow is a component of the base flow
- cave and aquifer systems – aquatic ecosystems that exist in karstic, cave, porous and fissured aquifers
- terrestrial fauna – native species that use groundwater directly for purposes other than habitat
- estuarine and near-shore marine systems – plant and animal communities reliant to some degree on the discharge of groundwater.

Appendix
Guidelines for assessing the potential risk of impact to groundwater dependent ecosystems

E

Process for assessing licences close to a groundwater-dependent ecosystem

The department may advise a licence applicant to complete an assessment of the potential risk of impact of the proposed abstraction to a nearby groundwater-dependent ecosystem. The level of information required at each step will be determined based on the associated level of hydrogeological assessment under Statewide policy no. 19, (an H1, H2 or H3), and will form part of the reporting requirements for these studies.

The guidelines in this appendix only apply to licence applications close to groundwater-dependent ecosystems that are wetlands, streamline (riparian) and terrestrial vegetation. Streamline vegetation can be categorised as 'terrestrial vegetation with a 0 to 3 m rooting depth to groundwater'. Refer to Section 5.1 for the policies regarding other types of groundwater-dependent ecosystems and contact the department if further advice is required.

The guidelines provide direction for the licence applicant at H1, H2 and H3 levels for the two major phases of assessment:

- location of potential groundwater-dependent ecosystems and definition of environmental value
- assessment of potential effects on groundwater-dependent ecosystems from proposed groundwater usage.

This information feeds into a decision matrix which gives the likely licence decision based on the environmental value and potential effects on the groundwater-dependent ecosystems.

1 Locate potential groundwater-dependent ecosystems and define their environmental value

Expectations of an H1 assessment

An H1 assessment should consist of at least the following sections:

- Map the location of potential groundwater-dependent ecosystems using your property as the central point within a 1:50 000 map scale (See Figure 6 to 8 for an overall guide to the possible locations of groundwater-dependent ecosystems).
- Assess the groundwater-dependent ecosystem types. This information is used in Table E3. Assessing the 'depth to groundwater' range of the terrestrial vegetation types is likely to be the most difficult part of this step. The department can be contacted for advice on depth to groundwater and the aquifer(s) that support the groundwater-dependent ecosystems.
- Assess the environmental value of the groundwater-dependent ecosystems. Use Tables E1 and E2 as a rating guide to assess their environmental values. Table E2 is not an exhaustive list of what the department considers to be high value ecosystems.
  Both the Department of Water and the Department of Environment and Conservation can be contacted for advice on environmental values of groundwater-dependent ecosystems. More advice can be sought from other agencies (as listed in Table E2).

E Appendix
Guidelines for assessing the potential risk of impact to groundwater dependent ecosystems

Table E1
Guide for assessing the environmental value of groundwater-dependent ecosystems in the South West groundwater areas

Environmental value	Guide
High	Supports high environmental values (see Table E2).
Moderate	Supports high environmental values that have been severely degraded by surrounding land-use or Has not been assessed for environmental values or Is poorly understood and has evidence of low to moderate degradation by surrounding land use
Low	Supports no recognised environmental values and has been moderately to severely degraded by surrounding land use.

Table E2
Potential groundwater-dependent ecosystems of high environmental value in the South West groundwater areas*

Type	Value
Public conservation reserves	• Nature reserves • National parks • Conservation parks See Department of Environment and Conservation <www.naturebase.com.au>
Native vegetation	• Threatened plant communities (DEC) • Significant vegetation • Greater Bunbury Region Scheme (WAPC) • Shire of Busselton Environment Strategy (ERMC 2004)
Biodiversity	• Declared rare and priority flora and fauna (DEC) • Threatened flora and fauna (DEC) • Threatened ecological communities (DEC)
Wetlands	• Ramsar listed wetlands <www.ramsar.org> • Directory of important wetlands (ANCA) See the Australian Wetlands database, Government of Australia, Department of Environment, Heritage and the Arts <www.environment.gov.au> • Environmental protection policy wetlands (DEC) • Conservation category wetlands (DoW) • Resource enhancement category wetlands (DoW)
Caves	• Caves of the Leeuwin–Naturaliste Ridge
Heritage	• Aboriginal heritage sites (DIA <www.dia.wa.gov.au>) • Register of National Estate See Environment Australia, Government of Australia, Department of Environment, Heritage and the Arts <www.environment.gov.au>

*see Hyde 2006 for a comprehensive description of these values

Expectations of an H2 assessment

In addition to the expectations for a H1 assessment, the applicant must conduct a field survey to confirm the distribution and condition of the groundwater-dependent ecosystems and assess the level of groundwater dependence and susceptible species within the vegetation community. The applicant is likely to need appropriately qualified professional advice for this assessment.

Expectations of an H3 assessment

The applicant will be required to obtain the assistance of appropriately qualified professionals to undertake a detailed assessment of the groundwater-dependent ecosystems in a regional context, including their identification, an inventory of groundwater-dependent species and ecosystems and an assessment of the potential impacts of the proposal on groundwater-dependent species and ecosystems.

2 Assess potential impact on groundwater-dependent ecosystems

Under *Statewide policy no. 19 – Hydrogeological reporting associated with a groundwater well licence* (DoW 2007b) the applicant will be required to assess the potential impact on the groundwater-dependent ecosystems from their groundwater licence. Assessments of estimated drawdown have to account for the cumulative effects of groundwater abstraction from all users.

Where information is available the subsequent assessment should also consider the historic (recent) patterns of groundwater level at the groundwater-dependent ecosystems. That is, have the groundwater-dependent ecosystems already been affected by groundwater abstraction or regional changes in water level? Information on historical patterns of use and neighbouring groundwater abstraction can be acquired from the department's licensing database records.

Expectations of an H1 assessment

The licence applicant will need to make a best estimate of the total amount of drawdown (summer water levels) at the groundwater-dependent ecosystems. The department can be contacted for further advice on estimating drawdown.

Following identification of the types of groundwater-dependent ecosystems and their potential drawdown, the information can be used to rate the potential risk of impact to the groundwater-dependent ecosystems as low, moderate, high or severe (Table E3). This rating is then used in the decision matrix for licence assessment (Table E4) to estimate if the licence proposal is likely to be acceptable.

Table E3
Potential risk of impact on groundwater-dependent ecosystems*

Groundwater-dependent ecosystem (GDE) type	Predicted water level drawdown at the GDE (metres)			
Wetland vegetation 0–3 m depth to groundwater	< 0.25	0.25–0.50	0.50–0.75	> 0.75
Streamline (riparian) vegetation – river base flow ecosystem	< 0.25	0.25–0.50	0.50–0.75	> 0.75
Terrestrial vegetation 0–3 m depth to groundwater	< 0.75	0.75–1.25	1.25–1.75	> 1.75
Terrestrial vegetation 3–6 m depth to groundwater	< 1.00	1.00–1.50	1.50–2.25	> 2.25
Terrestrial vegetation 6¬–10 m depth to groundwater	< 1.25	1.25–2.00	2.00–2.75	> 2.75
Potential risk of impact	**Low**	**Moderate**	**High**	**Severe**

* The potential risk of impact is measured as the predicted drawdown of the summer minimum water levels at the GDE after a specified period of groundwater abstraction (pumping).

Appendix E
Guidelines for assessing the potential risk of impact to groundwater dependent ecosystems

Expectations of an H2 assessment

At the H2 level of assessment, test pumping and monitoring of an observation bore or bores, or piezometer, is required. It is expected that the applicant will use this information to provide a more reliable assessment of the potential impacts on the groundwater-dependent ecosystem, and that data will be provided which can be related to an annual water level response at the groundwater-dependent ecosystem.

Expectations of an H3 assessment

The H3 level of assessment requires test pumping and the development of a local hydrogeological model to predict the potential impacts of the proposed abstraction regime. It is expected that the modelling component will provide annual water level response at the groundwater-dependent ecosystem for the life of the project or for a specified time period (usually 30 years) for permanent projects.

The likely licensing decision

The environmental value of the groundwater-dependent ecosystem and the risk of impact of the proposed abstraction are considered in the licensing approval process (Table E4). The department aims to maintain ecological values at a low level of risk wherever possible. Table E4 indicates the likely decision which will result from the licensing assessment decision process in the context of impact on water levels at the groundwater-dependent ecosystem only. The licensing decision process also considers many other factors such as impact on other users, groundwater quality and salt water intrusion.

Table E4
Decision matrix guide for licence assessment

Potential risk of impact to groundwater-dependent ecosystem	Environmental value		
	Low	Moderate	High
Low	Acceptable	Acceptable	Manageable
Moderate	Acceptable	Manageable	Manageable
High	Acceptable	Unacceptable	Unacceptable
Severe	Acceptable	Unacceptable	Unacceptable

The meanings of the terms acceptable, unacceptable and manageable are explained below:

Acceptable The licence is likely to be approved as impacts from proposed abstraction result in a low level of risk to the groundwater-dependent ecosystem.

Unacceptable The licence is likely to be refused as the impacts of the proposed abstraction exceed acceptable limits.

Manageable Further information or assessment may be required to define the level of impact on the groundwater-dependent ecosystem with a greater level of certainty. Alternatively, the licence may be approved with conditions such as monitoring requirements and impact management measures. These may include, but are not limited to:

- Installation and monitoring of monitoring bores
- Reassessment of risk of impact upon licence renewal
- Monitoring and assessment of condition of groundwater dependent ecosystems.

Glossary

abstraction	The permanent or temporary withdrawal of water from any source of supply, so that it is no longer part of the resources of the locality.
allocation limit	Annual volume of water set aside for use from a water resource.
aquifer	A geological formation or group of formations capable of receiving, storing and transmitting large quantities of water.
aquiclude	An impermeable layer within an aquifer formation that prevents transmission of water or pressure. Also see aquitard.
aquitard	A confining bed that retards but does not prevent the flow of water to or from an adjacent aquifer. It does not readily yield water to wells or springs but may serve as a storage unit for groundwater. Also called an aquiclude.
artesian aquifer	A confined aquifer in which the hydraulic pressure will cause water to rise in a bore or spring above the land surface. If the pressure is insufficient to cause the well to flow at the surface, it is called a sub-artesian aquifer.
artesian bore	A bore, including all associated works, from which water flows, or has flowed, naturally to the surface.
base flow	The component of stream flow supplied by groundwater discharge.
bore	An opening in the ground, normally vertical hole drilled in soil or rock, made or used to obtain access to underground water. This is equivalent to the description of a 'well' in *the Rights In Water and Irrigation Act 1914.*
calibration (groundwater model)	Calibration of a model is the process where parameters in the model are fine tuned to get the best possible match between actual and modelled data over a defined period.
confined aquifer	An aquifer lying between confining layers of low permeability strata (such as clay, coal or rock) so that the water in the aquifer cannot easily flow vertically.
critical asset	Ecological, social or cultural sites of significance that have been identified by the Department of Water as being groundwater-dependent and require protection to ensure that the values associated with the site are maintained at a low level of risk.
dewatering	Removing underground water for construction or other activity. It is often used as a safety measure in mining below the watertable or as a preliminary step to development in an area
discharge	The water that moves from the groundwater to the ground surface or above, such as a spring or the ocean. This includes water that seeps onto the ground surface, evaporation from unsaturated soil, and water extracted from groundwater by plants (evapotranspiration) or engineering works (groundwater pumping).
domestic bore	A bore used for providing the in-house and household garden watering requirements.
drawdown	The lowering of a watertable resulting from the removal of water from an aquifer or reduction in hydraulic pressure
ecological water requirements	The water regime needed to maintain ecological values of water-dependent ecosystems at a low level of risk.

environmental water provisions	The water regimes that are provided as a result of the water allocation decision-making process taking into account ecological, social, cultural and economic impacts. They may meet in part or in full the ecological water requirements
evaporation	Loss of water from the water surface or from the soil surface by vaporisation due to solar radiation.
evapotranspiration	The combined loss of water by evaporation and transpiration. It includes water evaporated from the soil surface and water transpired by plants.
first-in first-served	A process by which groundwater entitlements are allocated in the order in which licence applications are received by the Department of Water.
groundwater	The water that occurs in pore spaces and fractures in rocks beneath the ground surface. Also see aquifer, confined aquifer and unconfined aquifer.
groundwater area	An area proclaimed under the *Rights in Water and Irrigation Act 1914* for the purposes of licensing and managing water use.
groundwater-dependent ecosystem	An ecosystem that is dependent on groundwater for its existence and health.
hydrogeology	The hydrological and geological science concerned with the occurrence, distribution, quality and movement of groundwater, especially relating to the distribution of aquifers, groundwater flow and groundwater quality.
licence (5C)	A formal permit which entitles the licence holder to 'take' water from a watercourse, wetland or underground source.
lithology	The description of rocks on the basis of such characteristics as colour, structures, mineralogical composition, and grain size. The physical character of a rock.
m AHD	Australian Height Datum – height in metres above Mean Sea Level + 0.026m at Fremantle.
non-artesian well	A well, including all associated works, from which water does not flow, or has not flowed, naturally to the surface but has to be raised, or has been raised, by pumping or other artificial means
outcrop	Occurs where a confined aquifer formation is exposed to the surface of the surrounding land. In this instance the aquifer becomes unconfined. This area is usually the recharge zone of the aquifer.
potentiometric	A potentiometric surface represents the static water level (or head) of groundwater.
precautionary principle	Taking a cautious approach to development and environmental management decisions when information is uncertain, unreliable or inadequate.
public water supply reserve	Reservation of a volume of water to supply drinking water for human consumption.
purchaser	A person receiving a trade. Any person permitted by the *Rights in Water and Irrigation Act 1914* to hold a water licence is potentially able to purchase a licensed entitlement.
recharge	Water that infiltrates into the soil to replenish an aquifer.
recirculation	Where water is continually abstracted and re-applied from the same aquifer.
salinity	The measure of total soluble salt or mineral constituents in water. Water resources are classified based on salinity in terms of total dissolved solids (TDS) or total soluble salts (TSS). Measurements are usually in milligrams per litre (mg/L) or parts per thousand (ppt).
social value	A particular in-situ quality, attribute or use that is important for public benefit, welfare, state or health (physical and spiritual).
social water requirement	Elements of the water regime that are needed to maintain social and cultural values.
stock bore	A bore that provides drinking water for stock.

subarea	A smaller area determined by the Department of Water within a proclaimed area used for water allocation planning and management purposes. The boundaries of which are based on the location of the water resource.
subcropping	See outcrop. A subcrop occurs where the aquifer formation is just below the surface, becoming unconfined.
surface water	Water flowing over or held in streams, rivers and wetlands on the surface of the land.
sustainability	Meeting the needs of current and future generations through integration of environmental protection, social advancement and economic prosperity.
sustainable groundwater yield	The amount of water that can be abstracted/extracted over time from a water resource while maintaining the ecological values (including assets, functions and processes).
throughflow	The flow of water within an, and between, aquifers.
trade	Sale of part or all of a licensed entitlement/s, by a licensee (vendor) to a second party (purchaser). This involves moving the point of abstraction from one property to another.
transfer	A transfer is a change in ownership of the water licence associated with the sale of the property to which the licence applies. There is no change in the location of the abstraction. Licences can be transferred without recompense.
transpiration	The water taken up by plants normally measured in millimetres.
tremmie cement grouting	A cement grouting process used by groundwater drillers to backfill between the soil and the pipe.
unconfined aquifer	Is the aquifer nearest the surface, having no overlying confining layer. The upper surface of the groundwater within the aquifer is called the watertable. The aquifer contains water with no upper non-porous material to limit its volume or to exert pressure.
unconformity	A discontinuity in rock sequence indicating interruption of sedimentation, commonly accompanied by erosion of rocks below the break or the interface between such strata.
vendor	A licence holder wishing to trade a water entitlement is referred to as the vendor. Any person permitted by the *Rights in Water and Irrigation Act 1914* to hold a water licence is potentially able to sell a licensed entitlement.
water efficiency	The minimisation of water use through adoption of best management practices.
water entitlement	The quantity of water that a person is entitled to take on an annual basis in accordance with the *Rights in Water and Irrigation Act 1914* through a licence.
water reserve	An area proclaimed under the *Metropolitan Water Supply Sewerage and Drainage Act 1909* or *Country Areas Water Supply Act 1947* to allow the protection and use of water on or under the land for public water supplies.
watertable	The saturated water level of the unconfined aquifer. Wetlands in low-lying areas are often seasonal or permanent surface expressions of the watertable.
well	An opening in the ground made or used to obtain access to underground water. This includes soaks, wells, bores and excavations.
wetland	For the purposes of this plan (unless otherwise specified) the department adopts the Ramsar Convention definition of a wetland as *an area that is permanently, seasonally or intermittently waterlogged or inundated with water that may be fresh, saline, flowing or static, including areas of marine water of which the depth at low tide does not exceed six metres.*
yield	The volume of water that may be drawn from a well or water supply system measured in cubic metres per day, Gigalitres per year, or equivalent.

Volumes of water			
One litre	1 litre	1 litre	(L)
One thousand litres	1000 litres	1 kilolitre	(kL)
One million litres	1 000 000 litres	1 megalitre	(ML)
One thousand million litres	1 000 000 000 litres	1 gigalitre	(GL)

Shortened forms	
AHD	Australian height datum (in metres)
ANCA	Australian National Conservation Areas
ANZECC	Australian and New Zealand Environmental Conservation Council
Aqwest	Bunbury Water Board
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ASS	Acid sulfate soils
CENRM	Centre of Natural Resource Management
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEC	Department of Environment and Conservation
DIA	Department of Indigenous Affairs
DoW	Department of Water
DPC	Department of Premier and Cabinet
DPI	Department for Planning and Infrastructure
EPA	Environmental Protection Authority
ESCP	Eastern Scott coastal plain
EWR	Ecological water requirements
GDE	Groundwater-dependent ecosystems
IOCI	Indian Ocean Climate Initiative
IWSS	Integrated water supply scheme
NMBSC	National Minimum Bore Specifications Committee
PASS	Potential acid sulfate soils
ppt	Parts per thousand
PWS	Public water supply
SWAMS	South West aquifer modelling system
SWCC	South West Catchments Council
TDS	Total dissolved solids
TSS	Total soluble salts
WAPC	Western Australian Planning Commission
WC	Water Corporation
WRC	Water and Rivers Commission

References and recommended reading

ARMCA and ANZECC 2000, *Australian and New Zealand guidelines for fresh and marine water quality,* Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Commonwealth of Australia, Canberra.

——1995, *Guidelines for groundwater protection in Australia*, Commonwealth of Australia, Canberra.

——2000, *Australian Guidelines for water quality monitoring and reporting*, Commonwealth of Australia, Canberra.

Albert Haak and Associates Pty Ltd 2003, *Economic issues study report – Viticulture,* report to Water and Rivers Commission, Government of Western Australia, Perth.

Aquaterra Consulting Pty Ltd 2002, *Environmental dependence on surface and groundwater: Busselton–Capel area*, Water and Rivers Commission, Government of Western Australia, Perth.

——2006, *Eastern Scott coastal plain local scale groundwater and surface water model,* report to the Department of Water, Government of Western Australia, Perth.

Australian Government 2004, *National water quality management strategy – Australian drinking water guidelines 6*, National Health and Medical Research Council and Natural Resource Management Ministerial Council, Commonwealth of Australia, Canberra.

Australian Research Centre for Water in Society 2003, *Social values and impact study, South West Yarragadee, Blackwood groundwater area: The results of the South West and Perth community surveys*, CSIRO Land and Water, Perth.

Beckwith Environmental Planning Pty Ltd 2006, *Groundwater management in the South West: Bunbury, Busselton–Capel and Blackwood groundwater areas – Findings of stakeholder workshops*, report to the Department of Water, Government of Western Australia, Perth.

Brennan D 2004, *Current and future demand for irrigation water in Western Australia – Water demand study*, Department of Agriculture, Government of Western Australia, Perth.

——2006, *Economic evaluation of alternative water allocation options in the South West region (Busselton–Capel, Bunbury and Blackwood Groundwater areas)*, Technical report no 3/2006, CSIRO Water for a Healthy Country National Research Flagship, Canberra.

——2007, *Public water supply and irrigation water demand projections to 2030 in the South West water management region*, report to the Department of Water, Government of Western Australia, Perth.

Centre for Natural Resource Management 2005, *Ecological water requirements of Blackwood River and tributaries – Nannup to Hut Pool*, CENRM report 11/04, report to the Water Corporation, Perth.

——2006, *Blackwood River: Refining ecological water requirements for the allocation planning process (Nannup to Hut Pool)*, CENRM report 3/06, report to the Department of Water, Government of Western Australia, Perth.

Commander DP & Palandri RE 2006, *Groundwater level trends review of the aquifers in the Bunbury, Busselton–Capel and Blackwood groundwater areas 2005*, Hydrogeology report no 259, Department of Water, Government of Western Australia, Perth.

CyMod Systems Pty Ltd 2004, *Construction and calibration of the South West Yarragadee Aquifer model,* report to Water and Rivers Commission and Water Corporation joint investigations team, Perth.

Degens BP & Wallace-Bell P 2006, *Acid sulfate soil survey of shallow regolith on the Scott coastal plain,* Hydrogeological record series, record no HG24, Department of Water, Government of Western Australia, Perth.

Del Borrello NL 2008, *Management triggers and responses for groundwater-dependent ecosystems in the South West groundwater areas*, Water resource allocation planning report no 31, Department of Water, Government of Western Australia Perth.

Department of Environment 2005, *Margaret River catchment area (including Ten-Mile Brook catchment) drinking water source protection plan*, Water source protection series report no 53, Department of Environment, Government of Western Australia.

DPC — see Department of Premier and Cabinet

Department of Premier and Cabinet 2007a, *Sustainability assessment of the South West Yarragadee water supply development,* Sustainability Panel, commissioned by the State Water Council, Perth.

——2007b, *State Water Plan*, Government of Western Australia, Perth.

Department of Water 2004, *Private drinking water supplies,* Water quality protection note no 41, Department of Water, Government of Western Australia Perth.

——2005, *Investigating Western Australia's groundwater resources: A 15 year plan of action (2005 –2020)*, Hydrogeology record no HG 10, Department of Water, Government of Western Australia, Perth.

——2006a, *Surface hydrology of the Cape to Cape region,* Surface water hydrology series report no 21, Department of Water, Government of Western Australia, Perth.

——2006b, *Community drinking water sources – protection and management*, Water quality protection note no 9, Department of Water, Government of Western Australia, Perth.

——2006c, *Nutrient and irrigation management plans,* Water quality protection note no 33, Department of Water, Government of Western Australia, Perth.

——2006d, *Dewatering of soils at construction sites,* Water quality protection note no 13, Department of Water, Government of Western Australia, Perth.

——2006e, *Groundwater monitoring bores*, Water quality protection note no 30, Department of Water, Government of Western Australia, Perth.

——2006f, *Preston Beach water reserve drinking water source protection plan,* Water resource protection series report no 57, Department of Water, Government of Western Australia, Perth.

——2007a, *Statewide policy no 17 – Timely submission of required further information*, Department of Water, Government of Western Australia, Perth.

——2007b, *Statewide policy no 19 – Hydrogeological reporting associated with a groundwater well licence*, Department of Water, Government of Western Australia, Perth.

——2007c, *Local area management plan for the groundwater resources of the Kemerton subareas,* Water resource allocation plan no 17, Department of Water, Government of Western Australia, Perth.

——2007d, *Western Australia's Implementation Plan for the National Water Initiative*, Department of Water, Government of Western Australia Perth.

——2007e, *Guidelines for Water Meter Installation,* Department of Water, Government of Western Australia, Perth.

——2007f, *Leeuwin Spring catchment area and Fisher Road water reserve drinking water source protection plan*, Water resource protection series report no 79, Department of Water, Government of Western Australia, Perth.

——2008a, *Reviewing the allocation limits for the South West groundwater areas,* Water resource allocation planning report no 33, Department of Water, Government of Western Australia, Perth.

——2008b, *South West Regional Water Plan – Strategic directions*: *draft for public comment,* Department of Water, Government of Western Australia, Perth.

——2008c, *South West Regional Water Plan – supporting detail*: *draft for public comment,* Department of Water, Government of Western Australia, Perth.

——2008d, *Enforcement and prosecutions policy*, Department of Water, Government of Western Australia, Perth.

——2008e, *Quindalup water reserve drinking water source protection plan – Dunsborough, Yallingup and Quindalup town water supplies*, Water source protection series report no 88, Department of Water, Government of Western Australia, Perth.

——2008f, *Bunbury water reserve drinking water source protection plan – Bunbury and Dalyellup water supplies*, Water source protection series report no 96, Department of Water, Government of Western Australia, Perth.

——2008g, *South West groundwater areas monitoring program*, Water resource allocation planning report no 32, Department of Water, Government of Western Australia, Perth.

——2008h, *Statewide policy no 16 – Policy on water conservation / efficiency plans – achieving water use efficiency gains through water licensing*, Department of Water, Government of Western Australia, Perth.

——2009a, *Whicher area surface water allocation plan*, Water resource allocation planning report no 19, Department of Water, Government of Western Australia, Perth.

——2009b, *Water quality improvement plan for the Vasse Wonnerup wetlands and Geographe Bay draft for public comment*, Department of Water, Government of Western Australia, Perth.

——2009c, *Bunbury and South West Coastal groundwater areas subarea reference sheets, plan companion for the South West groundwater areas allocation plan*, Department of Water, Government of Western Australia, Perth.

——2009d, *Busselton–Capel groundwater areas subarea reference sheets, plan companion for the South West groundwater areas allocation plan*, Department of Water, Government of Western Australia, Perth.

——2009e, *Blackwood groundwater areas subarea reference sheets, plan companion for the South West groundwater areas allocation plan*, Department of Water, Government of Western Australia, Perth.

——2009f, *Statement of response – South West groundwater areas allocation plan*, Department of Water, Government of Western Australia, Perth.

Drake C 1995, *Educational and scientific use of wetlands and rivers in the Busselton–Walpole region*, Water Authority of Western Australia, Government of Western Australia, Perth.

Economic Consultancy Services 2003a, *Economic Issues Study Report – Horticulture*, report to the Water and Rivers Commission, Government of Western Australia, Perth.

——2003b, *South West Yarragadee – Blackwood groundwater area: Economic value study*, report to the Water and Rivers Commission, Government of Western Australia, Perth.

——2005, *South West Yarragadee – Blackwood groundwater area: Economic value study*, report to the Water Corporation, Perth.

Environmental Protection Authority 2006, *Environmental offsets – position statement no 9*, Environmental Protection Authority, Government of Western Australia, Perth.

Environmental Resource Management 2004, *South West Yarragadee Aquifer: Peer review panel report on South-West aquifer modelling system*, Department of Environment, Government of Western Australia, Perth.

——2005, *South West Yarragadee Aquifer – Peer review panel report on South-West aquifer modelling system* (SWAMS v. 2.0), Department of Environment, Government of Western Australia, Perth.

Eastern Metropolitan Regional Council 2004, *Shire of Busselton Environment Strategy*, Eastern Metropolitan Regional Council – Environmental Services, prepared for the Shire of Busselton, Western Australia.

Froend R & Loomes R 2005, *South West Yarragadee – Assessment of vegetation susceptibility and possible response to drawdown*, report to the Water Corporation, Perth.

——2006, *Determination of ecological requirements for wetland and terrestrial vegetation – Southern Blackwood and Eastern Scott coastal plain – Final report*, report to the Department of Water, Government of Western Australia, Perth.

——& Bertuch m 2006, *Determination of ecological requirements for wetland and terrestrial vegetation – Southern Blackwood and Eastern Scott coastal plain – Baseline vegetation monitoring results and monitoring protocol*, report to the Department of Water, Government of Western Australia, Perth.

Golder 2008, *Groundwater level trends analysis for the South West groundwater areas*, Golder and Associates report to the Department of Water and the Australian Government's Water for the Future – Water Smart Australia program, Perth.

Goode B 2003, *Aboriginal cultural values study report for the South West Yarragadee – Blackwood groundwater area,* report to the Department of Environment and submitted to the Department of Indigenous Affairs, Government of Western Australia, Perth.

Goode B & Irvine C 2006, *A survey of Aboriginal social water requirements for the Southern Blackwood Plateau and the Scott coastal plain, south-west Western Australia*, report to the Department of Environment and Department of Indigenous Affairs, Government of Western Australia, Perth.

Goodreid A 2007, *Social water requirements for the Blackwood groundwater area,* Environmental water report no 2, Department of Water, Government of Western Australia, Perth.

Hatton T & Evans R 1998, *Dependence of ecosystems on groundwater and its significance to Australia,* occasional paper no 12/98, Land and Water Resources Research and Development Corporation, Canberra.

Hennessy KJ, Whetton PH and Macadam I 2006, *Climate change scenarios for initial assessment of risk in accordance with risk management guidance,* prepared for the Australian Greenhouse Office, Department of the Environment and Heritage by CSIRO Marine and Atmospheric Research, Aspendale.

Hyde NL 2006, *A summary of investigations into ecological water requirements of groundwater-dependent ecosystems in the South West groundwater areas*, Environmental water report no 3, Department of Water, Government of Western Australia, Perth.

IOCI — see Indian Ocean Climate Initiative

Indian Ocean Climate Initiative 2002, *Climate variability and change in south-west Western Australia,* Indian Ocean Climate Initiative Panel, Perth http://www.ioci.org.au/

——2004, *How has our rainfall changed? The South West*, notes on changed climate in Western Australia – number 2, Indian Ocean Climate Initiative Panel, Perth.

——2005, *How our groundwater has changed*, Climate Note 8/05, Indian Ocean Climate Initiative Panel, Perth.

Irrigation Review Steering Committee 2005, *State Water Strategy: Irrigation Review,* Government of Western Australia, Perth.

Irwin R 2007, *Hydrogeology of the eastern Scott coastal plain,* Hydrogeology record no HG 19, Department of Water, Government of Western Australia, Perth.

Johnson S 2000, *Assessment of groundwater resources in the Busselton–Capel groundwater area,* Hydrogeology report no 164, Water and Rivers Commission, Government of Western Australia, Perth.

Madden S 1995, *Recreational use of water bodies in the Busselton-Walpole region,* Water Authority of Western Australia, Government of Western Australia, Perth.

Mattiske Consulting Pty Ltd, 2005a, *Review of the botanical values on the South West Yarragadee project areas,* report to the Water Corporation, Perth.

——2005b, *Review of the flora and vegetation on the South West Yarragadee project areas,* report to the Water Corporation, Perth.

McKenna M 2007, *The Leschenault Estuarine System, south-western Australia – condition statement and recommendations for management,* Department of Water, Government of Western Australia, Bunbury.

Morgan DL & Beatty SJ 2005, *Baseline study on the fish and fauna in the Blackwood River and its tributaries receiving discharge from the Yarragadee Aquifer,* report to the Department of Environment, Centre for Fish and Fisheries Research, Murdoch University, Perth.

National Land and Water Resources Audit 2000, *National land and water resources audit – Land salinity: groundwater salinity,* National Land and Water Resources Audit, Canberra.

National Minimum Bore Specifications Committee 2003, *Management minimum construction requirements for water bores in Australia,* Edn 2, 2003, Natural Resources, Mines and Energy, Queensland Government, Land and Water Biodiversity Committee, Canberra.

O'Connor R, Quartermaine G & Yates A 1995, *An investigation into the Aboriginal significance of wetlands and rivers in the Busselton–Walpole region,* Water Authority of Western Australia, Government of Western Australia, Perth.

Pen L 1997, *A systematic overview of environmental values of the wetlands, rivers and estuaries of the Busselton–Walpole region,* Water and Rivers Commission, WRAP 7, Government of Western Australia, Perth.

Primary Consulting Services 2003, *Economic issues study report – Dairy,* report to the Water and Rivers Commission, Government of Western Australia, Perth.

Rockwater Pty Ltd 2004, *Assessment of the Hydrogeology, drainage and potential effect on the watertable of drawdown in the Yarragadee Aquifer report,* report to the Water Corporation, Perth.

Schafer D, Kern A, & Johnson S 2007, *Cowaramup groundwater investigation,* Hydrogeology report series no 262, Department of Water, Government of Western Australia, Perth.

——2008, *Hydrogeology of the Leederville Aquifer in the western Busselton–Capel groundwater area*, Hydrogeology record no HG 31, Department of Water, Government of Western Australia, Perth.

Schafer DB and SL Johnson 2008, *Groundwater resource assessment of the western Busselton–Capel groundwater area*, Hydrogeological report series no 273, Department of Water, Government of Western Australia, Perth.

South West Catchments Council 2005, *South West Regional Strategy for Natural Resource Management*, South West Catchments Council, Bunbury.

Strategen 2004, *South West Yarragadee – Blackwood groundwater area, Water study report – main report*, report to the Water and Rivers Commission, Government of Western Australia, Perth.

——2005a, *Reasonable regional needs, South West water supply development position paper*, report to the Water Corporation, Perth.

——2005b, *Sustainability evaluation/ERMP scoping report South West Yarragadee water supply development*, report to the Water Corporation, Perth.

——2006a, *South West Yarragadee water supply development: Sustainability evaluation/ environmental review & management programme executive summary*, report to the Water Corporation, Perth.

——2006b, *South West Yarragadee water supply development: Sustainability evaluation/ environmental review & management programme response to public submissions*, prepared for the Water Corporation, Perth.

Sun H 2005, *Construction, calibration and application of the South West Yarragadee Aquifer model v2.0, Water Corporation*, Perth.

SWCC — see South West Catchments Council

Synnott and Mulholland Management Services 2005, *Social impact assessment report for the Water Corporation proposal to source water from the South West Yarragadee as part of the sustainability evaluation for the proposal*, report to the Water Corporation, Perth.

URS Australia Pty Ltd 2004a, *Establishment of interim ecological water requirements for the Blackwood groundwater area, WA – Stages 1 and 2 – Part A*, report to the Environmental Protection Authority and the Water and Rivers Commission, Government of Western Australia, Perth.

——2004b, *Hydrogeological assessment of groundwater-dependent ecosystems at St John Brook*, report to the Water Corporation, Perth.

——2004c, *Hydrogeological assessment of groundwater-dependent ecosystems of the Blackwood River area*, report to the Water Corporation, Perth.

——2004d, *Hydrogeological assessment of groundwater-dependent ecosystems of the Reedia wetlands*, report to the Water Corporation, Perth.

——2005, *Lake Quitjup Hydrology Study report,* report to the Water Corporation, Perth.

——2006, *Blackwood River valley model*, report to the Water Corporation, Perth.

——2007, *Mapping potential surface water – groundwater connectivity Blackwood catchment WA – phase one report*, prepared for the National Water Commission, Canberra.

V & C Semeniuk Research Group 2005, *Wetland mapping, classification and evaluation, southern Blackwood Plateau and eastern Scott coastal plain*, report to the Department of Environment, Government of Western Australia, Perth.

Varma S 2009, *Application of the SWAMS and the ESCP models to Southern Perth Basin groundwater resources assessment,* Hydrogeological report no 251, Department of Water, Government of Western Australia, Perth.

WAPC — see Western Australian Planning Commission

Western Australian Planning Commission 2005, *Busselton wetlands conservation strategy,* prepared by Western Australian Planning Commission in association with Department of Conservation and Land Management, Department of Environment, Department of Agriculture, Water Corporation, Shire of Busselton and Geocatch, Government of Western Australia, Perth.

——2008, *Better urban water management,* report prepared in partnership with Department of Water, Department of Planning and Infrastructure, Western Australia Local Government Association and the Commonwealth of Australia, Perth.

Water Authority 1994, *Bunbury groundwater area management plan*, Water Authority of Western Australia, Government of Western Australia, Perth.

——1995, *Busselton–Capel groundwater area management plan*, Water Authority of Western Australia, Government of Western Australia, Perth.

Water Corporation 2005a, *Interpretation of SWAMS 2.0 groundwater modelling results for regional areas of watertable decline*, IPB Report no A4-1631, Water Corporation, Perth.

——2005b, *South West Yarragadee Hydrogeological investigations and evaluation – Southern Perth Basin*, Water Corporation, Perth.

——2006, *Donnybrook drinking water reserve – drinking water source protection assessment*, Water Corporation, Perth.

Water Reform Implementation Committee 2007, *Government response to A Blueprint for water reform in Western Australia,* Government of Western Australia, Perth.

Water and Rivers Commission 2000a, *Statewide policy no 5 – Environmental water provisions policy for Western Australia,* Water and Rivers Commission, Government of Western Australia, Perth.

——2000b, *Mining and mine processing – mine dewatering,* Water Quality Protection Guidelines no 11, Government of Western Australia, Perth.

——2001, *Statewide policy no 6 – Transferable (Tradable) water entitlements for Western Australia*, Water and Rivers Commission, Government of Western Australia, Perth.

——2003a, *Statewide policy no 9 – Water licensing – Staged developments*, Government of Western Australia, Perth.

——2003b, *Statewide policy no 11 – Management of unused licensed water entitlements*, Government of Western Australia, Perth.

——2004, *Statewide policy no 10 – Use of operating strategies in the water licensing process*, Government of Western Australia, Perth.

Notes

DOW SWAP-RM0003 750 0509

Department of **Water**
168 St Georges Terrace, Perth, Western Australia
PO Box K822 Perth Western Australia 6842
Phone: 08 6364 7600
Fax: 08 6364 7601
www.water.wa.gov.au