



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

Murray

groundwater area
Subarea reference sheets

Department of Water

April 2012

Murray groundwater area: subarea reference sheets

Department of Water
April 2012

Department of Water
168 St Georges Terrace
Perth Western Australia 6000
Telephone +61 8 6364 7600
Facsimile +61 8 6364 7601
National Relay Service 13 36 77
www.water.wa.gov.au

© Government of Western Australia 2012

April 2012

This work is copyright. You may download, display, print and reproduce this material in unaltered form only (retaining this notice) for your personal, non-commercial use or use in your organisation. Apart from any use as permitted under the *Copyright Act 1968*, all other rights are reserved. Requests and inquiries concerning reproduction and rights should be addressed to the Department of Water.

ISBN 978-1-921907-20-3 (online)

Acknowledgements

The Department of Water acknowledges the following people for their contribution to this publication: Matthew Awang, Guy Chandler, Philip Denby, Carey Johnston, Rebecca Palandri, Christie Silva.

For more information about this report, contact:

Kwinana Peel Region
Department of Water
107 Breakwater Parade
Mandurah Western Australia 6210

PO Box 332
Mandurah Western Australia 6210

Telephone 08 9550 4222
Facsimile 08 9581 4560

Disclaimer

This document has been published by the Department of Water. Any representation, statement, opinion or advice expressed or implied in this publication is made in good faith and on the basis that the Department of Water and its employees are not liable for any damage or loss whatsoever which may occur as a result of action taken or not taken, as the case may be in respect of any representation, statement, opinion or advice referred to herein. Professional advice should be obtained before applying the information contained in this document to particular circumstances.

This publication is available at our website www.water.wa.gov.au or for those with special needs it can be made available in alternative formats such as audio, large print or Braille.

Contents

1	Introduction.....	1
2	Water allocation and licensing.....	3
2.1	Allocation limits	4
3	Subarea reference sheets	6
3.1	Coolup.....	8
3.2	Nambeelup	11
3.3	Pinjarra.....	15
3.4	Waroona	18
	Glossary	22
	References	24

Appendices

Appendix A — Map information and disclaimer	21
---	----

Figures

Figure 1	The Murray groundwater area and subarea boundaries	2
Figure 2	Coolup subarea	10
Figure 3	Nambeelup subarea	14
Figure 4	Pinjarra subarea	17
Figure 5	Waroona subarea.....	20

Tables

Table 1	Allocation limits and components for the Murray groundwater area ...	5
---------	--	---

1 Introduction

The Department of Water has developed the *Murray groundwater allocation plan* (DoW 2012b) to specify how abstraction and use of groundwater will be managed and to guide how water licensing decisions will be made in the Murray groundwater area under the *Rights in Water and Irrigation Act 1914*.

The subarea reference sheets are a supporting document to the plan. They provide detailed information about the hydrogeology as well as the ecological, cultural and social values for each of the four subareas in the Murray groundwater area (Figure 1). This information forms part of a water licence assessment, therefore the reference sheets are used:

- as a reference tool for licensing officers
- to assist applicants with the licensing process.

Licence application forms and up-to-date water availability information can be accessed on the Department of Water website <www.water.wa.gov.au> or by contacting the Kwinana Peel regional office (details are at the front of this report). Statewide and local licensing polices in the *Murray groundwater allocation plan* will also assist applicants submit licence applications with the relevant detail.

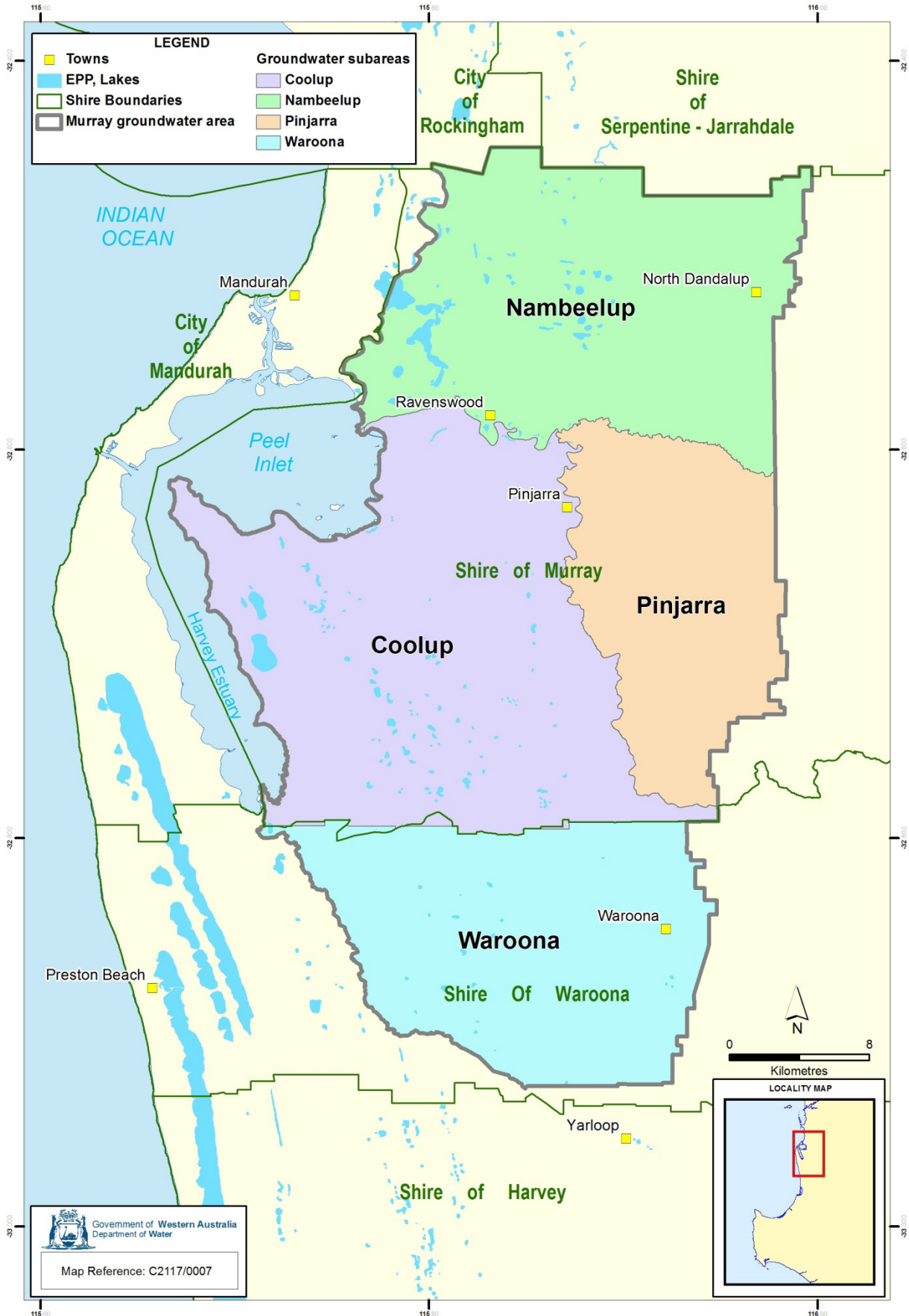


Figure 1 The Murray groundwater area and subarea boundaries

2 Water allocation and licensing

Water licences

The *Rights in Water and Irrigation Act 1914* establishes the legislative framework for managing and allocating water in Western Australia.

Before people in the Murray groundwater area can access groundwater, they need a licence issued under the provisions of section 26D of the *Rights in Water and Irrigation Act 1914* to construct or alter wells.

Water users in the Murray groundwater area require a water licence to lawfully take groundwater under section 5C of the *Rights in Water and Irrigation Act 1914*.

The granting of a water licence is through the department's assessment of individual applications to take water. As well as the allocation plan, we consider clause 7 (2) of Schedule 1 of the *Rights in Water and Irrigation Act 1914* for this assessment. Where water is available, it is allocated on a first-in first-served basis up to the allocation limit.

Groundwater dependent ecosystems in the area such as the Peel-Harvey Estuary and associated rivers and wetlands are managed and protected by state, federal and international legislation as well as state environmental policies which we also consider in our assessments:

- Environmental Protection Authority System 6 report (EPA 1983)
- Swan Coastal Plain lakes environmental protection policy (EPA 1992b)
- Peel-Harvey estuarine system environmental protection policy (EPA 1992a)
- *Wetlands of the Swan Coastal Plain, Volume 2b*, (geomorphic database for wetlands of the Swan Coastal Plain) (Hill et al 1996)
- *Convention on wetlands of international importance especially as waterfowl habitat (Ramsar convention of wetlands)* (UNESCO 1971)
- *Water quality improvement plan for the rivers and estuary of the Peel-Harvey system – phosphorus management* (EPA 2008).

To achieve integration between land and water planning we also consider:

- *Southern Metropolitan and Peel sub-regional structure plan* (WAPC 2009)
- *Directions 2031 spatial framework* (WAPC 2010)
- *State planning policy 2.9: Water resources* (WAPC 2006)
- *Better urban water management* (WAPC 2008)

Water resource management

The Department of Water is responsible for managing water resources in Western Australia consistent with the objects of Part III of the *Rights in Water and Irrigation*

Act 1914. Allocation plans define how the department manages in accord with object (a) of the Act:

- (a) To provide for the management of water resources, and in particular –
- (i) for their sustainable use and development to meet the needs of current and future users; and
 - (ii) for the protection of their ecosystems and the environment in which water resources are situated, including by the regulation of activities detrimental to them.

2.1 Allocation limits

In the Murray groundwater area the allocation limits are split into two components:

- licensable (general licensing, public water supply)
- unlicensable (exempt use including stock and domestic).

The volume of water set aside for licensing is the allocation limit minus the volume of water estimated and set aside for the unlicensed component.

The fractured rock resource allocation limits were set for management purposes only and do not represent expected yield. Fractured rock has not been included in the allocation limits table because the aquifer is hydrogeologically variable and abstraction reliability cannot be accurately predicted.

The actual volume of water available for licensing is subject to change as licence entitlements are issued or amended. For up-to-date information proponents are encouraged to contact the department's Kwinana Peel regional office in Mandurah or check the online water register on our website at www.water.wa.gov.au.

For the Murray groundwater area 25% of calculated recharge was set aside to remain in the superficial and Leederville resources to protect aquifer integrity, in situ values and groundwater-dependent ecosystems. The allocation limits are based on the remaining 75% of recharge. For more information see *Murray groundwater allocation limits method report* (DoW 2012a).

Table 1 Allocation limits and components for the Murray groundwater area

Subarea	Resource	Allocation limit GL/yr	Allocation limit components GL/yr			Is water available for licensing? ² (at April 2012)
			Unlicensable exempt use	Licensable general licensing	Licensable public water supply ¹	
Coolup	Superficial Swan	17.00	1.90	15.10		Yes
	Upper Leederville	4.50	0.00	4.50		Yes
	Lower Leederville	1.15 ³	0.00	1.15		No
	Cattamarra	0.10	0.00	0.10		Restricted
	Total	22.75	1.90	20.85	0.00	
Nambeelup	Superficial Swan	13.50	1.40	12.10		Yes
	Upper Leederville	3.00 ³	0.00	3.00		Limited
	Lower Leederville	3.00	0.00	2.00	1.00	Limited
	Cattamarra	0.60	0.00	0.60		Restricted
	Total	20.10	1.40	17.70	1.00	
Pinjarra	Superficial Swan	1.70	0.45	1.25		Yes
	Lower Leederville	1.80	0.00	1.80		Yes
	Cattamarra	2.60	0.00	2.60		No
	Total	6.10	0.45	5.65	0.00	
Waroona	Superficial Swan	8.00	1.20	6.80		Yes
	Upper Leederville	2.20	0.00	2.20		Yes
	Lower Leederville	1.50	0.00	1.50		Yes
	Cattamarra	0.10	0.00	0.10		Restricted
	Total	11.80	1.20	10.60	0.00	
Total for the plan area		60.75	4.95	54.80	1.00	

¹There are no drinking water source protection areas in the Murray groundwater area. The 1 GL is licensed for public water supply but is not utilised due to poor quality.

²Available water applies to the general licensing component only. 'Yes' means the component is less than 70% licensed, 'Limited' means more than 70% of the component is licensed, 'No' means 100% of the component is licensed and alternative sources such as trading or managed aquifer recharge should be investigated. Cattamarra is restricted by depth, availability and quality.

³These allocation limits have been reviewed and reduced since the plan for public comment. Section 2.3 explains the allocation limit decision.

3 Subarea reference sheets

For the Nambeelup, Coolup, Waroona and Pinjarra subareas the reference sheets outline the following information:

- proclamation, water use and water allocation issues
- hydrogeology
- ecological, social, cultural and recreational sites of significance

Hydrogeology

The hydrogeological descriptions in the reference sheets are derived from reports which detail the hydrogeology and groundwater resources of the Swan Coastal Plain and Perth region (Allen 1976; Allen 1979; Commander 1975; Commander 1982; Davidson 1995; Deeney 1989a; Deeney 1989b; Hall et al. 2010; McArthur and Bettenay 1960).

In the Murray groundwater area there are four sedimentary aquifers and a fractured rock aquifer system along the Darling Scarp. The aquifers in order of increasing depth are the superficial, Rockingham Sand, Leederville and Yarragadee aquifers.

The superficial and Rockingham Sand aquifers are hydraulically connected.

The Leederville aquifer is divided into the upper and lower Leederville. The upper Leederville consists only of the Wanneroo Member. The lower Leederville consists only of the Mariginiup Member. A green clay marker bed indicates the boundary between these two members. The Pinjar Member is absent.

The Yarragadee aquifer is a multilayered aquifer system. The Cattamarra Coal Measures is the main Yarragadee aquifer unit in the Murray groundwater area.

The fractured rock aquifer is located on the eastern edge of the Murray groundwater area along the Darling Scarp. It is characteristically similar across each subarea. Crystalline rocks of the Yilgarn Craton are variably overlain by a surficial covering of laterite or colluvium. Groundwater is restricted to fractures in the crystalline rocks, a thin weathered zone and the surficial sediments. Groundwater availability is expected to be highly variable and will generally be limited.

Ecology

When assessing a licence application, we consider nearby groundwater-dependent ecosystems. Many groundwater-dependent ecosystems contain or are linked to:

- declared rare flora, fauna and threatened ecological communities
- environmental protection policy wetlands (EPP wetlands)
- Australian national conservation areas (ANCA wetlands)
- Ramsar wetlands
- environmentally sensitive areas (clearing regulation areas)

- numerous water courses and their associated pools, bed and banks.

These sites are listed in the subarea reference sheets to highlight their presence. The level of knowledge on these sites may be limited. Because of this, we may require a licence applicant to undertake investigation work to prove that the proposed abstraction will not have an adverse impact on these sites or the aquifer.

Cultural

The claimant group listed and any reference to Aboriginal sites of significance (listed heritage sites) have been obtained from the Department of Indigenous Affairs database. The information only refers to those claims that have been determined and sites that are listed on the permanent register.

Gnaala Karla Booja is registered as the native title claimant group for the entire Murray groundwater area. Contact the South West Aboriginal Land and Sea Council for more information.

The sites listed in the subarea reference sheets are known to be linked to water. Licensing officers undertake a full search during the licence assessment process to determine if these sites will be effected by the application. Applicants may be required to undertake investigation work associated with an Aboriginal heritage site if it is likely to be disturbed. In this situation, the applicant would be advised to contact the Department of Indigenous Affairs.

Social

The major social water use values we consider are public and private drinking water (including domestic, stock and garden use) and recreational uses. The localities in each subarea are listed to help applicants find out which subarea they are located in. Although there are many different types of recreational sites related to water, only those which are known to be groundwater-dependent are listed.

3.1 Coolup

Coolup subarea description													
Area	362 km ²												
Proclamation	Murray groundwater area 1976												
Shire	Murray												
Rainfall	850mm ¹												
Water use (at September 2011)	<table border="1"> <caption>Water Use Distribution (at September 2011)</caption> <thead> <tr> <th>Category</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>Agriculture</td> <td>41%</td> </tr> <tr> <td>Parks, Gardens and Recreation</td> <td>35%</td> </tr> <tr> <td>Stock and Domestic</td> <td>12%</td> </tr> <tr> <td>Commercial and Institutional</td> <td>11%</td> </tr> <tr> <td>Mining and Industry</td> <td>1%</td> </tr> </tbody> </table>	Category	Percentage	Agriculture	41%	Parks, Gardens and Recreation	35%	Stock and Domestic	12%	Commercial and Institutional	11%	Mining and Industry	1%
Category	Percentage												
Agriculture	41%												
Parks, Gardens and Recreation	35%												
Stock and Domestic	12%												
Commercial and Institutional	11%												
Mining and Industry	1%												
Issues for water allocation													
<ul style="list-style-type: none"> • Acid sulphate soil risk: moderate to low in majority of the subarea. High along the Peel–Harvey Estuary and Murray River. • Dewatering and abstraction from the superficial aquifer may generate acid sulfate soils. • A saltwater interface exists along the western boundary of the subarea in the superficial, Rockingham sand and Leederville aquifers. • Local licensing policies and conditions will be applied to licenses issued to the superficial and Leederville resources to manage these issues. 													
Hydrogeology													
Aquifer	Description												
Superficial and Rockingham Sand	<p>The superficial aquifer in this subarea comprises the Quaternary Superficial formations and a small component of Rockingham Sands in the north west corner. The superficial formations include Tamala Limestone adjacent to the Peel-Harvey estuary, Gnangara Sand, Bassendean Sand, Guildford Clay adjacent to the Murray River, and Ascot Formation. The sediments consist of sand, clayey sand and sandy clay. Clay content increases from west to east.</p> <p>The Rockingham Sand is considered part of the superficial aquifer in this area because they are hydraulically connected. The Rockingham Sand occupies a paleochannel that underlies the superficial formations and cuts into the Leederville Formation. The channel runs east-west through the subarea and has been encountered to depths of up to 60 metres.</p> <p>The aquifer thickness increases progressively from east to west. Bore yields in the superficial aquifer can be variable and are dependent on sediment type. The higher the clay content, the lower the yields are likely to be. Groundwater is generally fresh to brackish with saline groundwater near the Peel-Harvey estuary.</p>												

Upper and Lower Leederville	<p>The Lower Leederville aquifer is present across all of the subarea. The Upper Leederville aquifer is absent in approximately one third of the subarea, along the length of the eastern boundary.</p> <p>The Upper and Lower Leederville aquifers are generally unconfined, particularly in the recharge areas in the eastern portion of the subarea but may become confined due to the interbedded shale, clay and sandstone layers.</p> <p>Groundwater in the Upper and Lower Leederville aquifers is fresh to brackish. Salinity may be higher beneath and immediately adjacent to the Peel-Harvey estuary due to leakage of saline water from the overlying superficial aquifer.</p>
Cattamarra	<p>The Cattamarra aquifer in the Coolup subarea consists of the Cattamarra Coal Measures and occurs throughout the subarea underlying the Leederville Formation. The Cattamarra aquifer is a confined aquifer composed of sandstone interbedded with siltstone and shale. Yields are likely to be poor in the eastern portion of the Coolup subarea, improving to the west with the increase in sandstone beds. Groundwater is likely to be brackish to saline.</p>
Key considerations for water management in Coolup	
Ecological	
<p><i>Wetlands and waterways:</i> The Peel–Harvey estuary is part of the Peel–Yalgorup Ramsar wetland system and forms the western boundary. Localised wetlands and seasonally inundated low lying palusplain are common; many are environmental protection policy wetlands and lakes. Water is drained out of the subarea through an extensive drainage network. Significant features include:</p> <ul style="list-style-type: none"> • Murray and Harvey rivers • Half of the Murray River delta where it connects with the Peel–Harvey estuary • Caris Main Drain, Buchanan, Coolup, Coolup South and Mayfield drains • Nine Mile Lake, Lake McClarty, Lake Meelup • Munginup and Boomer swamps. <p><i>Threatened ecological communities and declared rare flora sites:</i> Eight recorded threatened ecological community groupings associated with Austin Bay, Kooljerrenup, Lake McClarty, Nine Mile Lake and Lake Meelup nature reserves along the eastern edge of the Peel–Harvey estuary. Many site listings for declared rare and priority 1, 2 and 3 species associated with state forest, nature or road reserves.</p>	
Cultural	
<p><i>Aboriginal Heritage sites:</i> Murray River, Serpentine River, Waugal, Nine Mile Lake and various campsites and waterholes may be groundwater dependent.</p>	
Social	
<p><i>Towns and localities:</i> Birchmont, Blythewood, Coolup, Nirimba, Pinjarra, Point Grey, Ravenswood, South Yunderup, West Coolup and West Pinjarra. Domestic water supplied by rainwater tanks, groundwater, surface water and Integrated Water Supply Scheme.</p> <p><i>National parks, reserves and state forest:</i> Austin Bay, Kooljerrenup, Lake McClarty, McClarty, Nine Mile Lake and Lake Mealup nature reserves.</p> <p><i>Recreational sites:</i> Murray River, Peel–Harvey estuary and associated lakes and nature reserves.</p>	

1 Bureau of Meteorology and Department of Water average rainfall (1975–2009) recorded at telemetry monitoring sites. See <www.bom.gov.au> for more information.

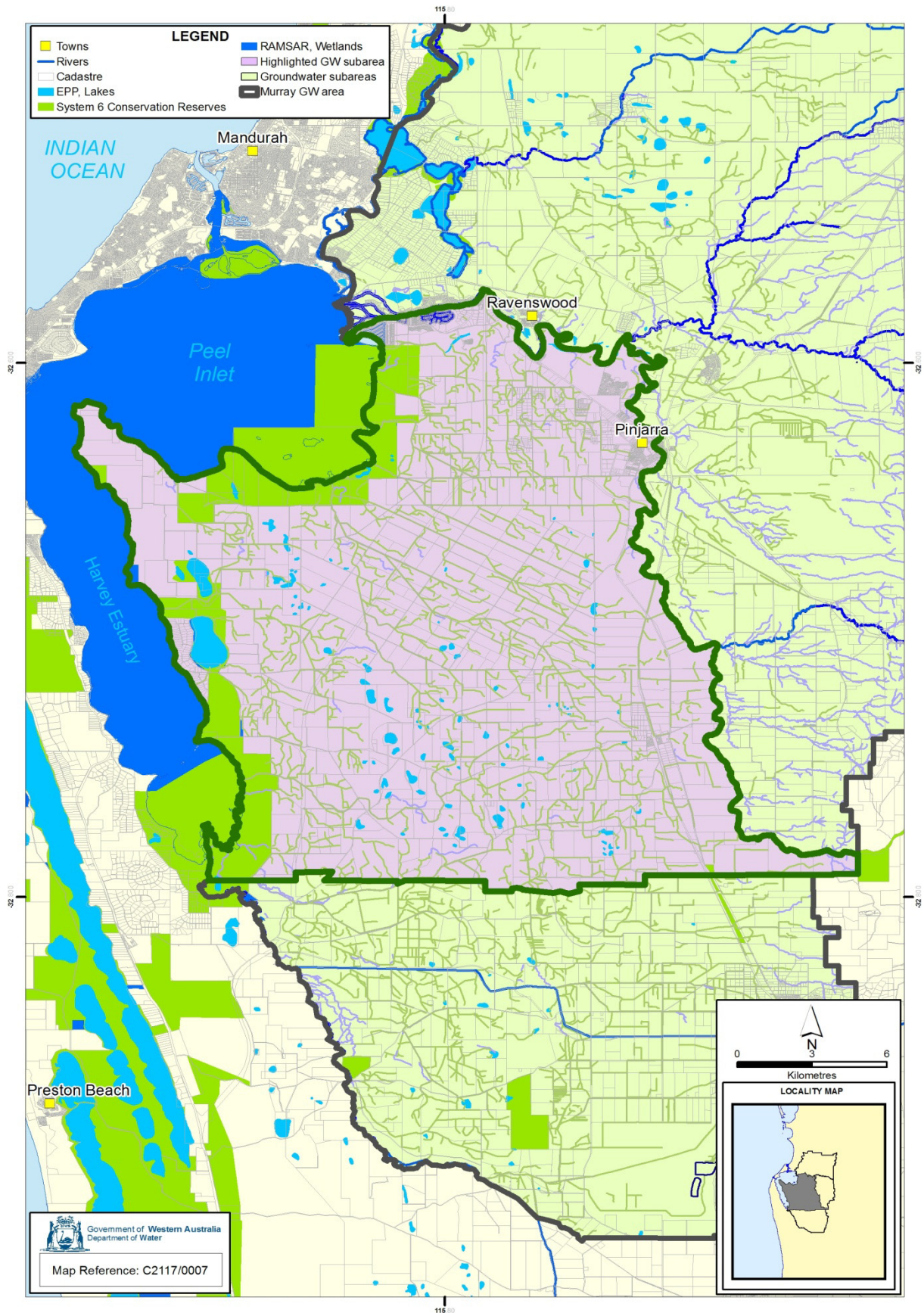


Figure 2 Coolup subarea

3.2 Nambeelup

Nambeelup subarea description															
Area	281 km ²														
Proclamation	Murray groundwater area 1976														
Shire	Murray														
Rainfall	850 mm ¹														
Water use (at September 2011)	<table border="1"> <caption>Water Use Distribution (September 2011)</caption> <thead> <tr> <th>Category</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>Agriculture</td> <td>57%</td> </tr> <tr> <td>Public Water Scheme Supply</td> <td>28%</td> </tr> <tr> <td>Stock and Domestic</td> <td>6%</td> </tr> <tr> <td>Mining and Industry</td> <td>4%</td> </tr> <tr> <td>Commercial and Institutional</td> <td>3%</td> </tr> <tr> <td>Parks, Gardens and Recreation</td> <td>2%</td> </tr> </tbody> </table>	Category	Percentage	Agriculture	57%	Public Water Scheme Supply	28%	Stock and Domestic	6%	Mining and Industry	4%	Commercial and Institutional	3%	Parks, Gardens and Recreation	2%
Category	Percentage														
Agriculture	57%														
Public Water Scheme Supply	28%														
Stock and Domestic	6%														
Mining and Industry	4%														
Commercial and Institutional	3%														
Parks, Gardens and Recreation	2%														
Issues for water allocation															
<ul style="list-style-type: none"> • Acid sulphate soil risk: moderate to low in majority of the subarea. High close to the Peel–Harvey Estuary and along the Serpentine, Nambeelup and Murray rivers. • Dewatering and abstraction from the superficial aquifer may generate acid sulfate soils. • A saltwater interface exists along the western boundary of the subarea in the superficial, Rockingham sand and Leederville aquifers. • Local licensing policies and conditions will be applied to licenses issued to the superficial and Leederville resources to manage these issues. 															
Hydrogeology															
Aquifer	Description														
Superficial and Rockingham Sand	<p>The superficial aquifer in this subarea comprises the Quaternary Superficial formations and Rockingham Sand.</p> <p>The superficial formations include Bassendean Sand, Guildford Clay and Yoganup Formation. The sediments consist of sand, clayey sand and sandy clay. Clay content increases from west to east.</p> <p>The Rockingham Sand is considered part of the superficial aquifer in this area because they are hydraulically connected. The Rockingham Sand occupies a paleochannel that underlies the superficial formations and cuts into the Leederville Formation. The channel runs east-west through the subarea and has been encountered to depths of up to 60 metres.</p> <p>Bore yields in the superficial aquifer can be variable and are dependent on sediment type. The higher the clay content, the lower the potential bore yields. Groundwater is generally fresh to brackish with saline groundwater near the Peel-Harvey estuary</p>														

<p>Upper and Lower Leederville</p>	<p>The lower Leederville aquifer is present across the entire subarea. In the eastern portion of the subarea the upper Leederville aquifer is absent. The Upper and Lower Leederville aquifers are generally unconfined, particularly in the recharge areas in the eastern portion of the subarea but may become confined to the west due to the interbedded shale, clay and sandstone layers. Groundwater is fresh to brackish.</p>
<p>Cattamarra</p>	<p>The Cattamarra aquifer in the Nambeelup subarea consists of the Cattamarra Coal Measures, Gage Sandstone (limited to the north west) and the Yarragadee Formation (limited to the north-east). All are hydraulically connected.</p> <p>The Cattamarra Coal Measures consists of interbedded sandstone, siltstones and shales with minor coal seams. The top of the Cattamarra aquifer increases in a westerly direction. It occurs at depths ranging from 10 metres adjacent to the Darling scarp (where it directly underlies the superficial formation) to greater than 250 metres where it is faulted to occur alongside the Yarragadee Formation further to the west.</p> <p>The Cattamarra aquifer is unconfined in the east, where the South Perth Shale is absent and the overlying sediments are thin. Elsewhere the aquifer is confined and artesian conditions may exist.</p> <p>Groundwater is generally fresh (0—1500 mg/L TDS) near the Darling Scarp.</p>
<p>Key considerations for water management in Nambeelup</p>	
<p>Ecological</p>	
<p><i>Wetlands and waterways:</i> The south west corner borders the Peel–Harvey Estuary which is part of the Peel–Yalgorup Ramsar wetland system. Localised wetlands and seasonally inundated low lying palusplain are common, many sites are environmental protection policy wetlands and lakes. Water is drained out of the subarea through an extensive drainage network. Significant features include:</p> <ul style="list-style-type: none"> • Serpentine River delta and half the Murray River delta • Serpentine, North Dandalup, Dandalup, South Dandalup and Murray rivers • Yalbanberup Pool (on Serpentine River) • Nambeelup Brook • Conjurunup Creek • Black and Goegrup lakes • Barragup Swamp. <p>(note: ecological water requirements study done for North Dandalup and Serpentine rivers).</p> <p><i>Threatened ecological communities and declared rare flora sites:</i> One recorded threatened ecological community site near Ravenswood and the Murray River. Many site listings of declared rare and priority 1, 2 and 3 species associated with state forest, nature reserves or road reserves.</p>	

Cultural

Aboriginal Heritage sites: Various campsites. Dandalup, Lake Goegrup, Tortoise swamp, Serpentine River, Barragup Lake, Murray River, Wolyanup Lake, Nambeelup Brook, Bulbiba Lake, Cogrup Lake and water holes that may be groundwater dependent.

Social

Towns and localities: Barragup, Fairbridge, Furnissdale, Nambeelup, North Dandalup, North Yunderup, Ravenswood, Stakehill and part of South Yunderup. Ravenswood and North Dandalup are connected to Integrated Water Supply Scheme. Water for domestic supply outside these towns comes from rainwater tanks, surface water and groundwater.

National parks, reserves and state forest: Goegrup and Black Lake nature reserves. Foreshore reserve along the Serpentine River.

Recreational sites: Peel–Harvey estuary and Serpentine, North Dandalup, South Dandalup and Murray rivers.

- 1 Bureau of Meteorology and Department of Water long-term average rainfall (1975–2009) recorded at telemetry monitoring sites. See <www.bom.gov.au> for more information.

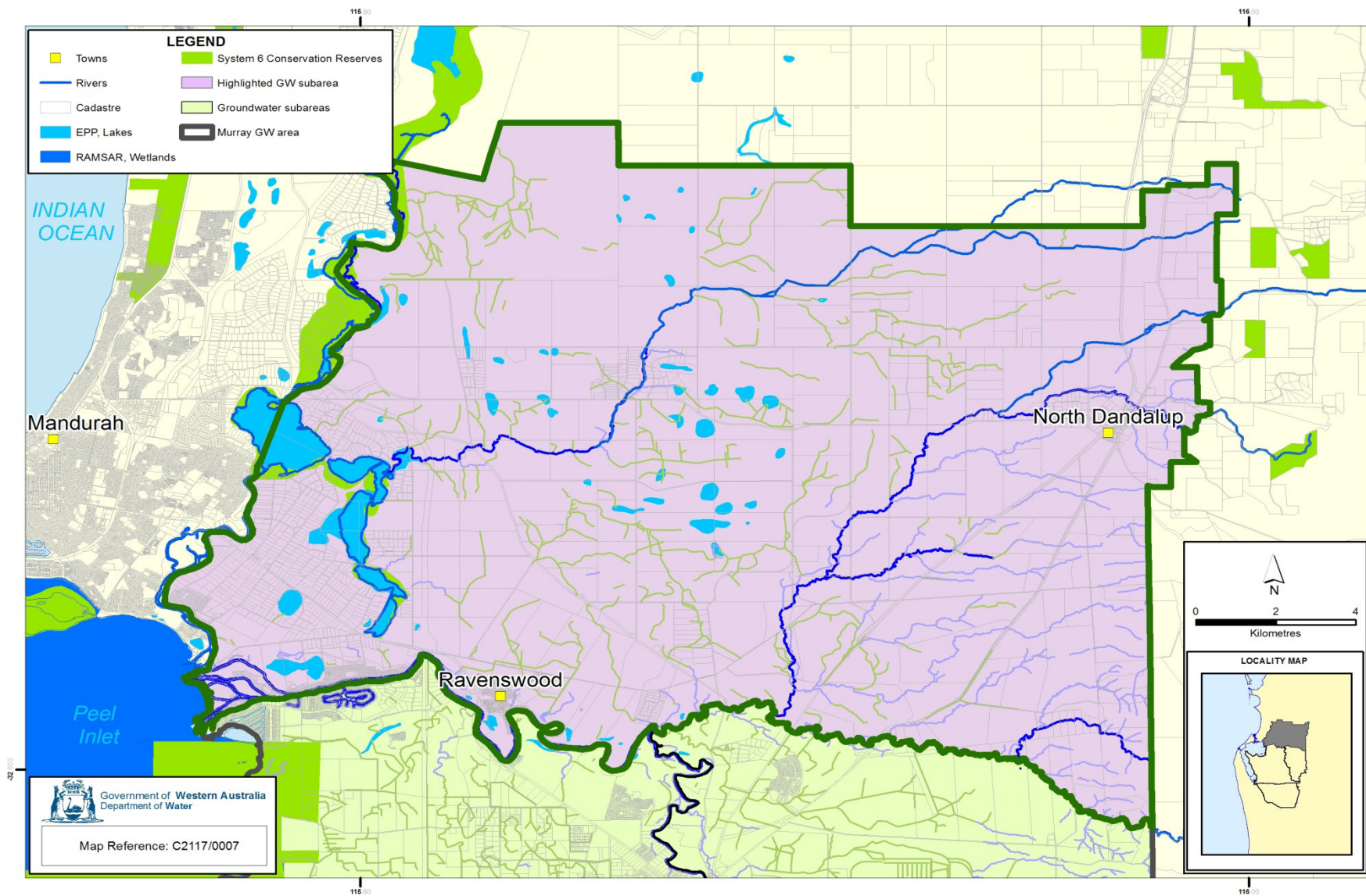


Figure 3 Nambelup subarea

3.3 Pinjarra

Pinjarra subarea description											
Area	169 km ²										
Proclamation	Murray groundwater area 1976.										
Shire	Murray										
Rainfall	850 mm ¹										
Water use (at September 2011)	<table border="1"> <caption>Water Use Data (at September 2011)</caption> <thead> <tr> <th>Category</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>Agriculture</td> <td>3%</td> </tr> <tr> <td>Mining and Industry</td> <td>91%</td> </tr> <tr> <td>Parks, Gardens and Recreation</td> <td>5%</td> </tr> <tr> <td>Stock and Domestic</td> <td>1%</td> </tr> </tbody> </table>	Category	Percentage	Agriculture	3%	Mining and Industry	91%	Parks, Gardens and Recreation	5%	Stock and Domestic	1%
Category	Percentage										
Agriculture	3%										
Mining and Industry	91%										
Parks, Gardens and Recreation	5%										
Stock and Domestic	1%										
Issues for water allocation											
<ul style="list-style-type: none"> • Acid sulphate soil risk: moderate to low west of the Darling Scarp. • Local licensing policies and conditions will be applied to licenses issued to the superficial and Leederville resources to manage these issues 											
Hydrogeology											
Aquifer	Description										
Superficial	The superficial aquifer in the Pinjarra subarea comprises the Quaternary Superficial formations. The superficial formations include colluvium adjacent to the Darling Scarp, minor Bassendean Sand, Guildford Clay and Yoganup Formation. Clay with sandy clay, gravel and minor sand are encountered in the subarea. Due to the high clay content, yields are expected to be low. Groundwater is generally fresh to slightly brackish.										
Lower Leederville	The Upper Leederville aquifer is absent throughout the Pinjarra subarea. The Lower Leederville aquifer is present across most of the subarea, although it is absent in an area east of the Darling Scarp. The Lower Leederville aquifer consists of interbedded sandstone, siltstone and clay and bore yields are generally limited. Groundwater is fresh to saline.										
Cattamarra	The Cattamarra aquifer exists throughout the Pinjarra subarea and consists primarily of the Cattamarra Coal Measures, with minor quantities of Gage Sandstone. The Cattamarra Coal Measures and Gage Sandstone are hydraulically connected. The Cattamarra aquifer consists of interbedded										

	<p>sandstones, siltstones and shales, with minor coal seams. The distribution of the Gage Sandstone is limited to the north-west of the subarea.</p> <p>The top of the Cattamarra aquifer directly underlies the superficial formations in an area immediately adjacent to the Darling Scarp. In all other parts of the subarea it is confined by the superficial formations, Lower Leederville aquifer and the South Perth Shale.</p> <p>The top of the Cattamarra aquifer increases in a westerly direction and occurs at depths ranging from approximately 35 m in the east (near the Darling scarp) to greater than 200 m in the western portion of the subarea.</p> <p>The Cattamarra aquifer is semi-confined in the eastern portion of the subarea, where the Lower Leederville aquifer and South Perth Shale are absent, and the superficial formations are relatively thin. Elsewhere in the subarea the aquifer is confined and artesian conditions may exist in low-lying areas.</p> <p>Groundwater is generally fresh although salinity is believed to increase with depth.</p>
Key considerations for water management in Pinjarra	
Ecological	
<p><i>Wetlands and waterways:</i> West of the Darling Scarp localised wetlands and seasonally inundated low lying palusplain are common. Water is drained out of the subarea through an extensive drainage network. Significant features include:</p> <ul style="list-style-type: none"> • South Dandalup and Murray rivers • Cornish and Tate gullies • Barritt, Marrinup and Oakley brooks. <p>(note: ecological water requirements study done for Marrinup Brook.)</p> <p><i>Threatened ecological communities and declared rare flora sites:</i> Three recorded threatened ecological communities associated with Meelon and an unnamed nature reserve. Many site listings for declared rare and priority 1, 2 and 3 species associated with state forest, nature reserves or road reserves.</p>	
Cultural	
<p><i>Aboriginal Heritage sites:</i> Murray River Waugal, Wurdaatji Cave, Fairbridge farm and various campsites and waterholes that may be groundwater dependent.</p>	
Social	
<p><i>Towns and localities:</i> Blythwood, Fairbridge, Marrinup, Meelon, Oakley, Ravenswood and Pinjarra. Pinjarra is connected to the Integrated Water Supply Scheme. Water for domestic supply outside Pinjarra comes from rainwater tanks, surface water and groundwater.</p> <p><i>National parks, reserves and state forest:</i> Meelon Nature Reserve and Marrinup State Forest.</p> <p><i>Recreational sites:</i> Fairbridge Farm, South Dandalup and Murray rivers.</p>	

1 Bureau of Meteorology and Department of Water long-term average rainfall (1975–2009) recorded at telemetry monitoring sites. See <www.bom.gov.au> for more information.

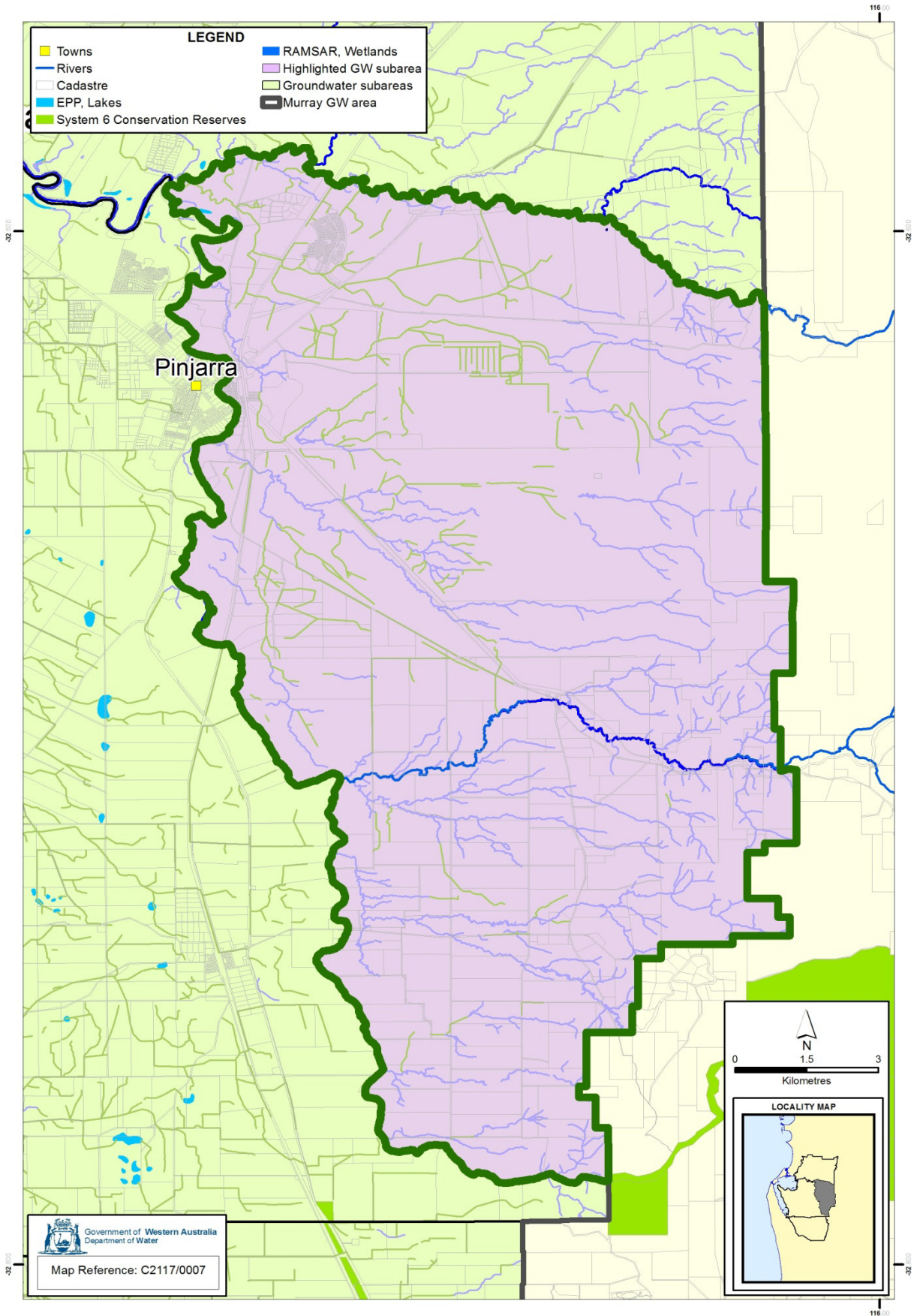


Figure 4 Pinjarra subarea

3.4 Waroona

Waroona subarea description													
Area	234 km ²												
Proclamation	Murray groundwater area 1976.												
Shire	Waroona												
Rainfall	850 mm ¹												
Water use (at September 2012)	<table border="1"> <caption>Water Use Distribution (at September 2012)</caption> <thead> <tr> <th>Category</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>Mining and Industry</td> <td>89%</td> </tr> <tr> <td>Parks, Gardens and Recreation</td> <td>8%</td> </tr> <tr> <td>Agriculture</td> <td>1%</td> </tr> <tr> <td>Commercial and Institutional</td> <td>1%</td> </tr> <tr> <td>Stock and Domestic</td> <td>1%</td> </tr> </tbody> </table>	Category	Percentage	Mining and Industry	89%	Parks, Gardens and Recreation	8%	Agriculture	1%	Commercial and Institutional	1%	Stock and Domestic	1%
Category	Percentage												
Mining and Industry	89%												
Parks, Gardens and Recreation	8%												
Agriculture	1%												
Commercial and Institutional	1%												
Stock and Domestic	1%												
Issues for water allocation													
<ul style="list-style-type: none"> • Acid sulphate soil risk: moderate to low in majority of the subarea. High around the delta of the Harvey River. • Dewatering and abstraction from the superficial aquifer may generate acid sulfate soils. • A saltwater interface exists along to the Harvey River, the western boundary of the subarea. • Local licensing policies and conditions will be applied to licenses issued to the superficial and Leederville resources to manage these issues. • Due to high clay soils yield from the superficial aquifer may be low, particularly in the eastern half of the subarea. 													
Hydrogeology													
Aquifer	Description												
Superficial	<p>The superficial aquifer in this subarea and comprises the Quaternary Superficial formations. The superficial formations include the Gngangara Sand, Bassendean Sand and Ascot Formation.</p> <p>Adjacent to the Darling Scarp colluvium overlies Guildford Clay and Yoganup Formation.</p> <p>The sediments consist of sand, clayey sand and sandy clay. Clay content increases from west to east. Groundwater is fresh to brackish.</p>												

Upper and Lower Leederville	The Lower Leederville aquifer is present throughout the subarea. The top of the Lower Leederville aquifer is expected to occur at around 0 m AHD. The upper Leederville aquifer only occurs in the western half of the subarea. Groundwater is generally fresh adjacent to the scarp and becomes marginal to brackish towards the west. Salinity also increases with depth.
Cattamarra	The Cattamarra aquifer in the Waroona subarea consists of the Cattamarra Coal Measures. It occurs throughout the subarea underlying the superficial and Leederville aquifers. The Cattamarra is a confined aquifer composed of sandstone interbedded with siltstone and shale. Yields are likely to be poor in the eastern portion of the Waroona subarea, improving to the west with the increase in sandstone beds. Groundwater is likely to be brackish to saline.
Key considerations for water management in Waroona	
Ecological	
<p><i>Wetlands and waterways:</i> The Harvey River forms the western boundary. Localised wetlands and seasonally inundated low lying palusplain is common, many sites are environmental protection policy wetlands and lakes. Water is drained out of the subarea through an extensive drainage network. Significant features include:</p> <ul style="list-style-type: none"> • Harvey River • Black Tom, Drakes, Ferraro, Hull, Samson and Yalup brooks • Drakesbrook, Mayfield, Samson South, Waroona and Yalup Brook drains. <p>(note: preliminary ecological water requirements study done for Drake, Ferraro, Samson, Samson South and Yalup brooks).</p> <p><i>Threatened ecological communities and declared rare flora sites:</i> Five recorded threatened ecological community groups, associated with Buller Nature Reserve and South Western Highway. Many site listings of declared rare and priority 1, 2 and 3 species associated with state forest, nature reserves or road reserves.</p>	
Cultural	
<p><i>Aboriginal Heritage sites:</i> Black Bream Pool, Wuradjie Waterfall, Peel–Harvey estuary, Drake Road Dampland, Harvey River and various campsites and waterholes may be groundwater dependent.</p>	
Social	
<p><i>Towns and localities:</i> Hamel, Wagerup and Waroona. Waroona is connected to the Integrated Water Supply Scheme. Water for domestic supply outside Waroona comes from rainwater tanks, surface water and groundwater. Harvey Water, a privately owned irrigation cooperative, supplies water for major irrigation projects in the Waroona irrigation zone of the Harvey irrigation area (outside this plan area).</p> <p><i>National parks, reserves and state forest:</i> Hamel State Forest, Buller Nature Reserve and part of Kooljerrenup Nature Reserve.</p> <p><i>Recreational sites:</i> Harvey River and the Peel–Harvey estuary.</p>	

1 Bureau of Meteorology and Department of Water long-term average rainfall (1975–2009) recorded at telemetry monitoring sites. See <www.bom.gov.au> for more information.

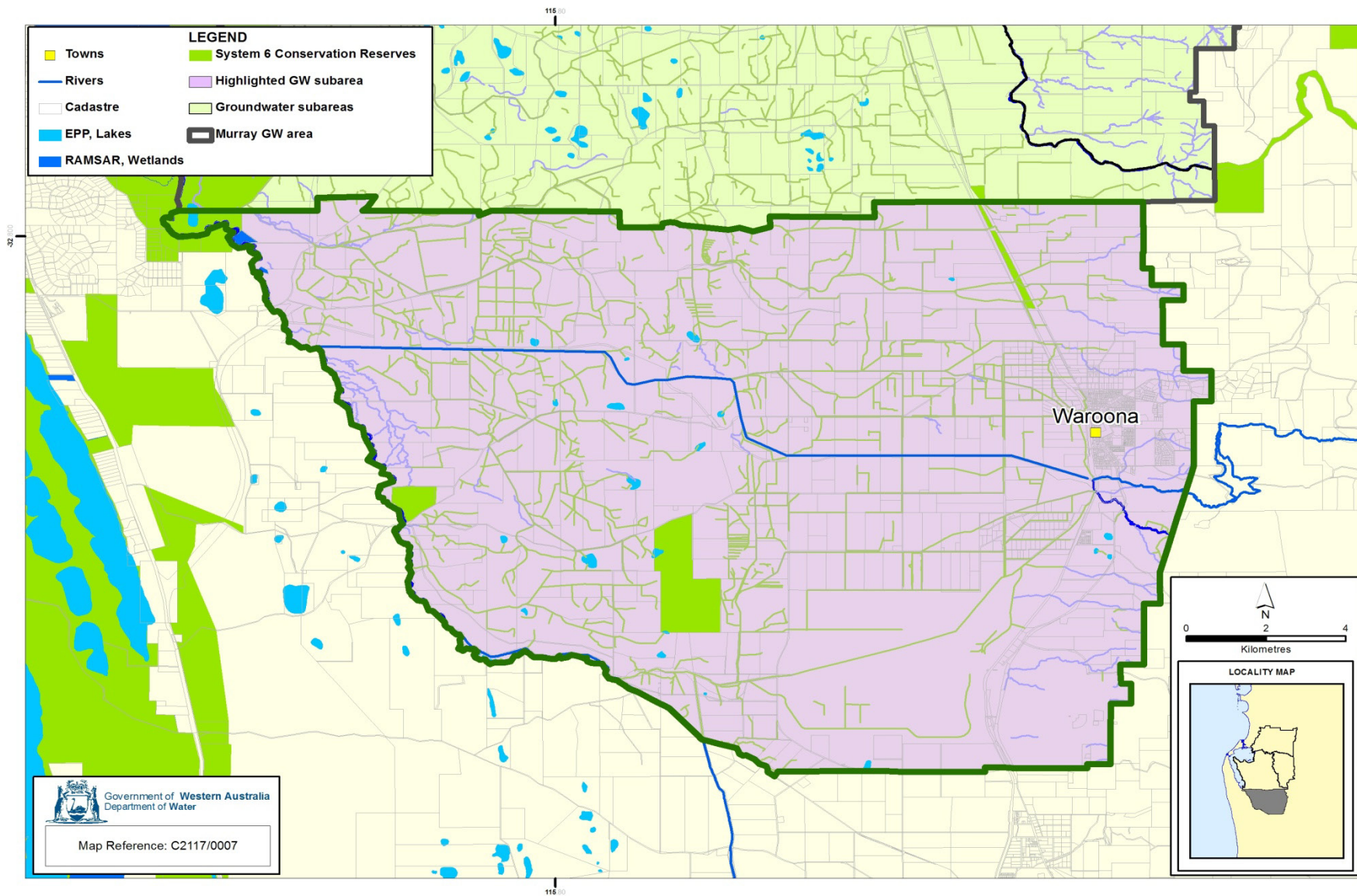


Figure 5 Waroona subarea

Appendix A - Map information and disclaimer

Datum and projection information

Vertical datum: Australian Height Datum (AHD)

Horizontal datum: Geocentric Datum of Australia 94

Projection: MGA 94 Zone 50

Spheroid: Australian National Spheroid

Project information

Client: Christie Silva

Map author: Gary Floyd and Shona Shah

File path: J:\gisprojects\Project\C_series\C2117...For all maps

File name: J:\gisprojects\Project\C_series\C2117\0007_Plan_Maps... For all maps

Compilation date: 09 March 2012

Disclaimer

These maps are a product of the Department of Water, Water Assessment and Allocation Division and were printed as shown.

These maps were produced with the intent that they be used for information purposes at the scale as shown when printing.

While the Department of Water 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

The Department of Water acknowledges the following datasets and their custodians in the production of this map:

Hydrography, Linear (Hierarchy) – DoW – 2007

WA Coastline, WRC (Poly) – DoW –2006

RIWI Groundwater Areas – DoW – 2012

Groundwater Subareas – DoW – 2012

Spatial Cadastral Database (SCDB) – Landgate – 2012

Western Australian Towns –Landgate – 2012

Local Government Authority and Locality Boundaries – Landgate – 2006

EPP Lakes Policy Area – DEC – 1992

Ramsar Wetlands – DEC – 2006

EPA Proposed Conservation Reserves – DEP – 2006

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 consumptive use from a water resource. This includes water available for licensing and water for uses exempt from licensing.
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.
Consumptive use	The use of water for private benefit (consumptive purposes) including irrigation, industry, urban and stock and domestic use.
Dewatering	Removing underground water to facilitate 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.
Exempt use	Water use that is not required to be licensed under the <i>Rights in Water and Irrigation Act 1914</i> . This is sometimes referred to as stock and domestic use or a riparian right.
First-in first-served	A process by which groundwater entitlements are allocated consistent with the order in which licence applications are received by the Department of Water.
Groundwater area	An area proclaimed under Part III, Division 3, section 26B (1) of the <i>Rights in Water and Irrigation Act 1914</i> for the purposes of licensing and managing water use.
Groundwater-dependent ecosystem	An ecosystem that is dependent on groundwater for its existence and health.
Groundwater resource	A Department of Water management term to define the portion of an aquifer present in a groundwater subarea.
In situ values	The ecological, social, cultural and resource values supported by natural hydrological and hydrogeological processes
Licence	A formal authorisation which entitles the licence holder to 'take' water from a watercourse, wetland or underground source for a specified quantity and period of time.
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 primarily defined by the location of the water resource.

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. An aquifer containing water with no upper non-porous material to limit its volume or to exert pressure.
Water entitlement	The quantity of water that a person is entitled to take on an annual basis in accordance with the <i>Rights in Water and Irrigation Act 1914</i> and a licence.
Water entitlement transaction	A water entitlement transaction can be a trade, transfer or lease of a licensed entitlement. Trade: Sale of part or all of a licensed entitlement, 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. Lease: A lease is where part or all of a licensed entitlement is leased for a price to another licensee. The abstraction point can be from either the vendor's or the lessee's bore.
Yield	The calculated volume of water that can be taken out of the system renewably after the water requirements for in situ values have been accounted for.

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)

List of shortened terms

CSIRO	Commonwealth scientific and industrial research organisation
DoW	Department of Water
EPA	Environmental Protection Authority
UNESCO	United Nations Educational, Scientific and Cultural Organisation
WAPC	Western Australian Planning Commission

References

- Allen AD 1976, 'Outline of the hydrogeology of the superficial formations of the Swan coastal plain', *Western Australia Geological Survey annual report 1975*, Government of Western Australia, Perth.
- 1979, 'An outline of the confined groundwater resources in the vicinity of Perth, Western Australia', *Western Australia Geological Survey annual report 1978*, Government of Western Australia, Perth.
- Bureau of Meteorology, 2009, *Climate data online*, Australian Government, Canberra <www.bom.gov.au/climate/averages/#climatemap> accessed 23 August 2009.
- Commander DP 1975, *Hydrogeology of the Mandurah–Pinjarra area, Perth Basin, WA*, Geological Survey of Western Australia, Record 1975/3, Government of Western Australia, Perth.
- 1982, *An outline of the groundwater resources of the Mandurah–Bunbury Region*, report 2412, Water and Rivers Commission, Government of Western Australia, Perth.
- Davidson WA 1995, *Hydrogeology and groundwater resources of the Perth region, Western Australia*, Western Australia Geological Survey, Bulletin no. 142, Government of Western Australia, Perth.
- Deeney AC 1989a, *Geology and groundwater resources of the superficial formations between Pinjarra and Bunbury Perth Basin*, Report 26, Western Australia Geological Survey professional papers, pp 38–58, Government of Western Australia, Perth.
- 1989b, *Hydrogeology of the Harvey Borehole Line, Perth Basin*, Report 26, Western Australia Geological Survey professional papers, pp 59–68, Government of Western Australia, Perth.
- Department of Water 2012a, *Murray groundwater allocation limits method report*, Department of Water, Perth.
- 2012b, *Murray groundwater allocation plan*, Department of Water, Perth
- Environmental Protection Authority 1983, *Conservation reserves for Western Australia – The Darling System, System 6*, report no. 13, Department of Conservation and Environment, Perth.
- 1992b, *Environmental protection (Swan coastal plain lakes) policy*, Environmental Protection Act 1986, Perth.
- 1992a, *Environmental protection (Peel Inlet–Harvey Estuary) policy*, Environmental Protection Act 1986, Perth.
- 2008, *Water quality improvement plan for the Rivers and Estuary of the Peel-Harvey System – Phosphorus management*, Environmental Protection Authority, Perth.

- Hall J, Kretschmer P, Quinton B and Marillier B, 2010 *Murray hydrological studies: surface water, groundwater and environmental water conceptual model report*, Water Science Technical Series WST 16 Department of Water, Government of Western Australia, Perth.
- Hill A, Semeniuk C, Semeniuk V and Del Marco A 1996, *Wetlands of the Swan coastal plain, Volume 2b*, report to the Water and Rivers Commission, V and C Semeniuk Research Group, Perth Western Australia.
- McArthur WM, and Bettenay E 1960, *The development and distribution of soils of the Swan coastal plain, Western Australia*, CSIRO, Soil Publication no. 16, Australian Government, Perth.
- Western Australian Planning Commission 2006, *State planning policy 2.9:Water resources*, Western Australian Planning Commission, Perth.
- 2008, *Better urban water management*, Western Australian Planning Commission, Perth.
- 2009, *Southern metropolitan and Peel sub-regional structure plan (draft)*, Western Australian Planning Commission, Perth.
- 2010, *Directions 2031: spatial framework for Perth and Peel*, Western Australian Planning Commission, Perth.
- UNESCO 1971, *Convention on wetlands of international importance especially as waterfowl habitat*, (Ramsar convention on wetlands), United Nations Educational, Scientific and Cultural Organization, Switzerland.

Legislation

Government of Western Australia 1914, *Rights in Water and Irrigation Act*, Perth.



RECYCLED CONTENT

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

3670 00 0412