



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

Arrowsmith

groundwater allocation plan



Looking after all our water needs

Water resource allocation
planning series
Report no 28
August 2010



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Department of Water

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Foreword



The *Arrowsmith groundwater allocation plan* provides the Department of Water's direction for the allocation and licensing of the groundwater resources in the Arrowsmith groundwater area.

The department allocates groundwater that is used for a wide range of purposes. Our aim is to ensure that the use of our groundwater resources is efficient and fit for purpose. We also balance current uses and future demand, while maintaining our water-dependent ecosystems and the water resource. This is important for the state's Mid West region because demand for water from competing industries is likely to rapidly change this balance unless it is carefully managed.

Our goal is to manage the groundwater resources in the Arrowsmith groundwater area in the best interests of the whole community, considering the water needs of regional development while maintaining the region's natural water assets.

Your input through the submissions we received on the *Arrowsmith groundwater area allocation plan: for public comment* has helped us to improve the plan. Our responses to the submissions are described in *Statement of response – Arrowsmith and Jurien groundwater allocation plans*.

A handwritten signature in black ink, appearing to be 'Graham Jacobs', written over a light blue wavy background element.

Dr Graham Jacobs MLA
Minister for Water; Mental Health

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Summary

Arrowsmith groundwater allocation plan

The Department of Water uses water allocation plans to manage how water is taken from groundwater and surface water systems.

We manage our groundwater systems in the context of the whole water cycle. Our challenge is to meet existing and future demand, while maintaining the productive base of the natural resource and its dependent ecosystems, now and into the future.

The need for a plan in this area

The Arrowsmith groundwater area covers the northern-most extent of the Northern Perth Basin, from Geraldton to Green Head and east to Coorow, in the state's Mid West region. Mining, public water supply and agricultural production are the major water uses. The distribution of groundwater resources and the competition for groundwater is such that careful management is required.

This allocation plan builds on and supersedes previous allocation plans established for this area (see WRC 2002; WAWA 1995).

This allocation plan provides:

- an update on how we allocate and licence groundwater in the Arrowsmith groundwater area
- our approach to managing the effects of abstraction on groundwater quality and groundwater-dependent ecosystems

- how we will implement and review the allocation plan.

The plan will be used to manage the allocation of groundwater for a variety of industries including mining and agriculture, and for the expected growth in population along the coast as the region expands.

Finalising the plan using the public submissions

This plan has been finalised by using the public submissions received on the *Arrowsmith groundwater area allocation plan: for public comment* (DoW 2009). The department received nine submissions from a range of individuals and groups. Our response to the comments received and how they have improved this plan are described in *Statement of response – Arrowsmith and Jurien groundwater allocation plans* (DoW 2010).

Water use and availability

The department considered the current groundwater resources and their quality in determining the amount of water available for allocation in this plan. The total volume of water available for take annually from all groundwater resources in the Arrowsmith groundwater area is 189.3 GL.

Of this total, 184.9 GL of groundwater can be allocated for licensing from all aquifers and subareas annually, with approximately 4.4 GL exempt from licensing for stock and/or domestic purposes.

The volume of licensed entitlements in the Arrowsmith groundwater area in April 2010 was 53.9 GL for general consumption and 14.6 GL for public water supply. We have reserved 18.5 GL for public water supply to meet demand until 2040. There is approximately 97.9 GL from all resources available for new users.

The Arrowsmith groundwater area contains seven sedimentary aquifers and fractured rock aquifer systems. The Yarragadee and Leederville–Parmelia aquifers are the main groundwater resources used. Other sedimentary aquifers are localised and have lower yields which makes them less viable. The Superficial aquifer is unconfined and widely used in the region for stock, mining and horticultural purposes.

Although groundwater is available throughout the plan area, complex hydrogeology, naturally variable water quality and the distribution of each aquifer may restrict possibilities for abstraction in particular cases.

Future groundwater use in the Arrowsmith groundwater area will be constrained by the quality and quantity of groundwater available for licensing. The high demand will result in competition for groundwater between various industries.

Once the allocation limits have been reached, meeting further demand will only be possible by increasing water use efficiency, by trading or by developing alternative sources.

Allocation and licensing approach

The plan sets out the department's approach to water allocation in the Arrowsmith groundwater area. The plan directs how the department allocates groundwater through the licensing process. This includes how we manage the impacts of use and the policies for granting licence entitlements. All licensing decisions will be made in accordance with the objectives of the plan.

Chapter one

Introduction

This water allocation plan provides the Department of Water's direction on how groundwater in the Arrowsmith groundwater area will be allocated and managed under the current *Rights in Water and Irrigation Act 1914*.

This plan updates and replaces *Managing the water resources of Arrowsmith groundwater area WA – interim sub-regional allocation strategy* (WRC 2002).

This plan applies to all groundwater users in the Arrowsmith groundwater area. The plan provides a systematic and transparent approach to groundwater licensing and promotes the responsible and efficient use of groundwater. The department developed this plan in response to:

- growth and competing demand for groundwater between industries, particularly in high water use areas
- demand for groundwater to meet population growth along the coastal areas
- pressure to supply groundwater for industrial use north and east of Geraldton and to meet mining demand outside the plan area (through movement of water)
- the existing and potential environmental impacts resulting from groundwater abstraction.

The challenge for water allocation in the Arrowsmith groundwater area is promoting efficient and fit-for-purpose use of groundwater resources that have variable quality and capacity within the limits set by the department. The complex nature of the groundwater resources and their location means that the groundwater is not always present in sufficient quantities or of a particular quality to meet demand.

This has led to many water use sectors being concentrated in areas where there is water of appropriate quantity and quality. Industries wanting to use groundwater should be matched with the appropriate source and quality of water to achieve the highest and best use of the groundwater resources.

A number of technical documents have informed the development of this plan, and explain the reason for the plan and background to the decisions made in it. They include:

- *Statement of response – Arrowsmith and Jurien groundwater allocation plans* (DoW 2010a)
- *Arrowsmith groundwater area allocation plan: for public comment* (DoW 2009a)
- *Review of the Jurien and Arrowsmith groundwater allocation limits* (DoW 2009b)
- *Arrowsmith groundwater area subarea reference sheets* (DoW 2009c)

Introduction

- *Environmental considerations for groundwater management in the Northern Perth Basin* (Del Borrello and Benton, 2009)
- *Groundwater vision – Northern Perth Basin* (NACC and DoW 2007)

The references section contains other environmental and planning related references that have been used to develop this plan.

1.1 Purpose of the plan

The purpose of the plan is to guide sustainable groundwater allocation decisions, while promoting efficient use of the resources to optimise water use for regional growth.

1.1.1 Visions for water management in the Northern Perth Basin area

The department's broader visions and directions for water resource management in the Arrowsmith groundwater area will be communicated through the forthcoming Mid West Regional water plan. This strategic water plan will provide guidance for the management, conservation and development of all water resources in the region for the next 20 years. It will describe the challenges we face and the action needed to respond to these challenges.

1.2 Scope of the plan

The department has developed this plan using a level two allocation planning response (R2). For an R2 response, the department develops an allocation plan, including setting allocation limits (see DoW 2009b) using available information, and uses these limits as the main instrument for protecting the

water-dependent environment. This is appropriate for a category two (C2) level of use (where resources in the plan area are generally less than 70% allocated).

The plan provides:

- the allocation planning boundaries, by subarea and groundwater resource
- the amount of groundwater available for allocation
- our approach to managing groundwater including:
 - the objectives for the water resource and water management
 - policies for allocating water licence entitlements
 - how we will implement, evaluate and review the plan.

1.3 The plan area

1.3.1 Location

The Arrowsmith groundwater area is located in the Northern Perth Basin, 200 km to 400 km north of Perth and covers an area of approximately 10 350 km² (Figure 1). The plan area is located north of the Jurien groundwater area and south and east of the Gascoyne groundwater area. It contains large portions of the shires of Coorow, Carnamah, Irwin and Three Springs, and smaller portions of the Shire of Mingenew and City of Geraldton-Greenough.

1.3.2 Proclamation

The groundwater resources in the Arrowsmith area were originally proclaimed as the Eneabba (1972), Allanooka (1973), Mingenew (1973) and North West Coastal (1975) groundwater areas. The Arrowsmith groundwater area replaced these in 1988, and was varied in 1990 under the *Rights in Water and Irrigation Act 1914*. The proclamation authorised the licensing of groundwater abstraction to protect the water resources for all users.

1.4 Water resources covered by this plan

For allocation planning and licensing purposes, the department has divided the Arrowsmith groundwater area into eight subareas (Figure 1). Their boundaries are based on hydrogeological information, such as fault lines or major aquifer features.

The department defines a groundwater resource as an aquifer in a given subarea, and sets an allocation limit for each resource (see Section 3).

The plan covers the unconfined and confined (including semi-confined) groundwater resources of the Arrowsmith groundwater area. The aquifer boundaries that the department has used to define the resources for this plan are shown in Figure 2 (unconfined) and Figure 3 (confined).

Each aquifer has different groundwater characteristics that are associated with the saturated hydrogeological formation, location and groundwater recharge. A brief summary of the hydrogeology in the Arrowsmith groundwater area is presented in Appendix A.

The following aquifers have been identified based on the geology and hydrogeology in the Arrowsmith groundwater area. They are listed according to age and depth:

1	Superficial
2	Surficial
3	Mirrabooka
4	Leederville–Parmelia
5	Yarragadee
6	Cattamarra
7	Eneabba
8	Lesueur

Of the seven aquifers, the Superficial, Leederville–Parmelia and Yarragadee aquifers currently provide most of the water abstracted (for public water supply, agriculture, horticulture and mining).

Many of the groundwater resources in the Arrowsmith groundwater area have naturally variable water quality (ranging from fresh to saline) and several of the confined aquifers are present only in small areas of a particular subarea (see Figure 3 and Appendix A).

To find out which subarea a particular property is located in see *Arrowsmith groundwater area subarea reference sheets* (DoW 2009c) or contact the department's Mid West Gascoyne regional office in Geraldton.



Figure 1
 The plan area (Arrowsmith groundwater area) and subareas
 Arrowsmith groundwater allocation plan

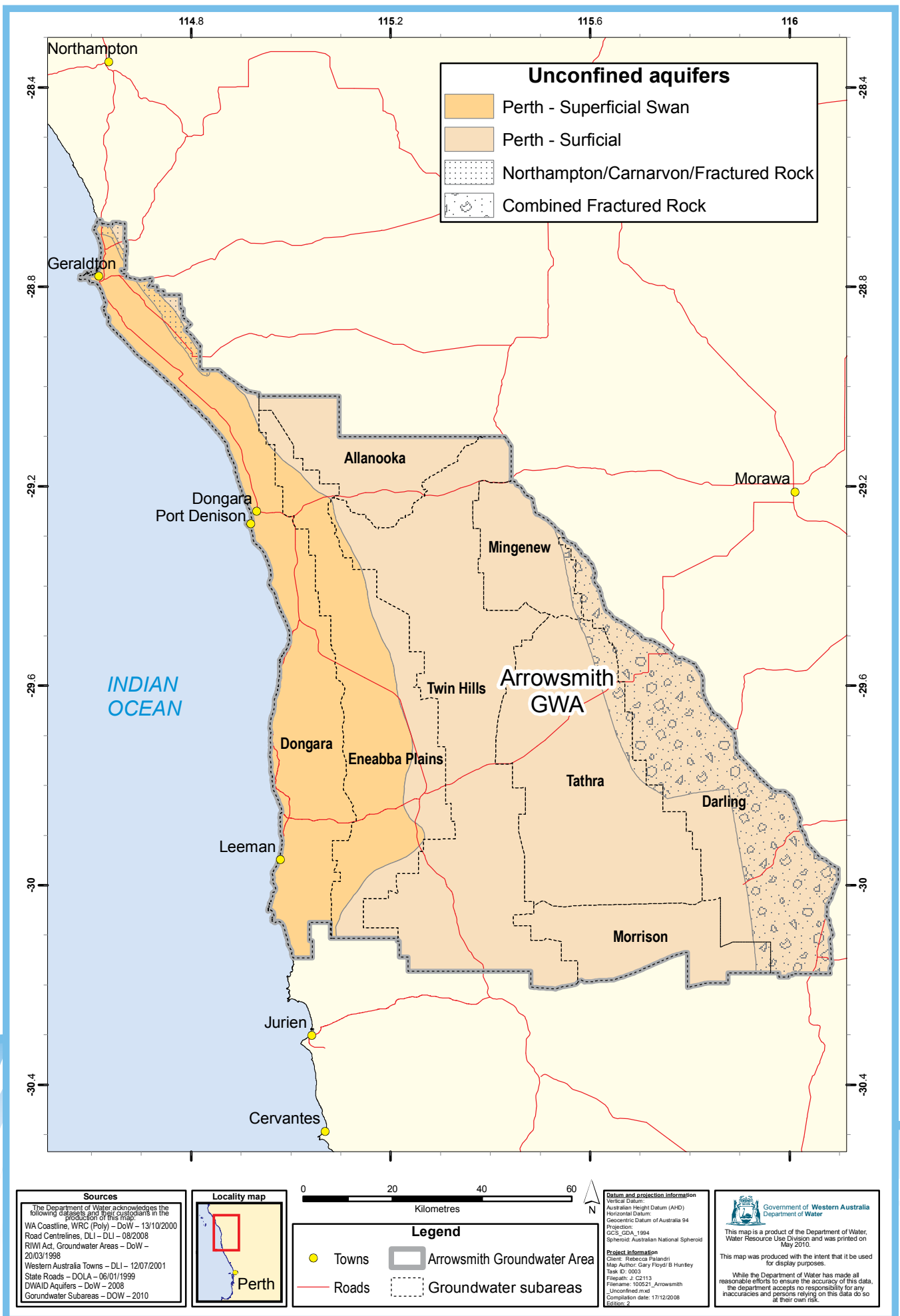


Figure 2
 Unconfined aquifer boundaries in the Arrowsmith groundwater area
 Arrowsmith groundwater allocation plan

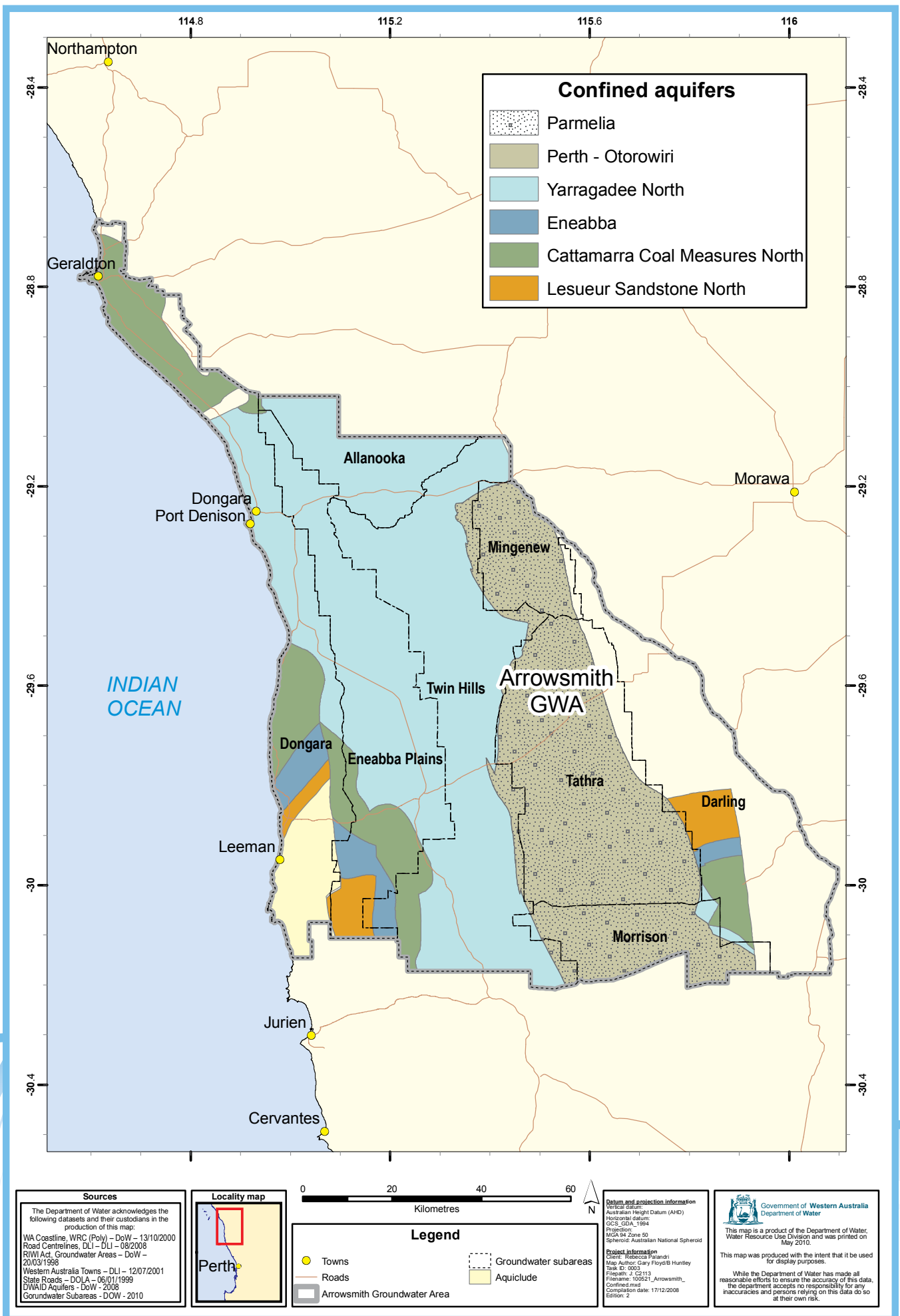


Figure 3
 Confined aquifer boundaries in the Arrowsmith groundwater area
 Arrowsmith groundwater allocation plan

1.5 When and for how long will this plan apply?

The *Arrowsmith groundwater allocation plan* will come into effect from the day that the Minister for Water endorses this plan.

This plan is scheduled to be reviewed after 2017. The plan will be reviewed earlier if the plan evaluation process recommends a review.

1.6 Updating legislation and this plan

The government of Western Australia is currently reviewing and updating its legislation for the state's water resources.

The approach and structure of this plan is consistent with the requirements of the *Rights in Water and Irrigation Act 1914* and, as far as possible, with the intent and purpose of the new legislation.

Once new legislation is enacted a future update of this plan will incorporate the appropriate changes and mechanisms for allocating water.

Chapter two

What we want this plan to achieve and how we will measure it

In the Arrowsmith groundwater area, the department aims to achieve sustainable allocation of groundwater to support local economic development where it does not affect groundwater-dependent ecosystems or water supply to existing water users.

2.1 Objectives

The water resource objectives of this plan are:

- a To maintain adequate groundwater levels to sustain the renewable capacity of the water resource.
- b To manage the needs of the groundwater-dependent ecosystems by maintaining adequate groundwater levels in unconfined and semi-confined aquifers.
- c To manage water quality (salinity) of both fresh and saline groundwater resources for fit-for-purpose use.

The water management objective of this plan is:

- d To increase the efficiency of use of groundwater.

2.2 How will the plan achieve its objectives?

To meet the objectives of this plan we will:

- apply the department's approach for allocating (Section 4.1) and licensing water (Section 4.2)
- licence water according to the licensing policies in Section 4.3
- carry out the actions in Section 6.1.

Chapter three

Allocation limits

An allocation limit is the total volume of water that the department sets aside to be used annually from a resource. This includes licensed and unlicensed use. The department allocates water up to the allocation limits for each of the groundwater resources.

The methodology we used to review and update the allocation limits is documented in *Allocation limit review for the Arrowsmith and Jurien groundwater areas* (DoW 2009b).

While the plan sets the total amount of water available for use annually from each groundwater resource, the actual volume of water available for licensing varies as licensed entitlements are issued or amended. Water availability is therefore subject to change, so licence applicants are encouraged to contact the department's Mid-West Gascoyne Region office in Geraldton for current information.

The allocation limits and status of water availability (as at April 2010) are presented in Table 1. We have not set allocation limits for the fractured rock aquifers, as they are assessed on an impact management basis, as described in the licensing policies of this plan.

We may revise allocation limits in the future if important new information becomes available. Drilling investigations and monitoring (water

levels and quality trends) may provide more information on how the resource performs and changes over time, and this may require the limits to be reviewed. Any changes to allocation limits will be reported in the annual evaluation statement.

3.1 Components of the allocation limit

The allocation limit consists of three components:

- licensable components (including general licensing and licensed public water supply)
- unlicensable components (including water for exempt unlicensed use)
- reserves (including future public water supply reserves).

The allocation limit, its components, and the status of water availability for licensing for each resource in the Arrowsmith groundwater area is shown in Table 1.

The water set aside for general licensing in the Arrowsmith groundwater area is the allocation limit minus the water set aside for unlicensed use and reserves. The status of water availability for licensing shows whether there is water available from the general licensing component (Table 1). Water availability and licensed use information is provided on a subarea basis, and in some cases specific licensing policies apply (see Section 4 and DoW 2009c).

3

Allocation limits

It is important to note that although an allocation limit has been assigned to a groundwater resource this does not automatically mean that volume of water can be abstracted from a single point. For example, if there is a total of 5 GL/yr of water available from the aquifer, abstraction of this volume may only be possible if distributed over a number of sites.

Table 1
Groundwater allocation limits and water available for licensing

Resource		Allocation limit ¹ kL/yr	Unlicensed components		Licensable component	Status of water availability for licensing ²
Subarea	Aquifer		Public water supply reserve kL/yr	Exempt unlicensed kL/yr	General licensing kL/yr	
Allanooka	Yarragadee	28 800 000	8 000 000	300 000	20 500 000	water available
Darling	Cattamarra	(400 000)	0	0	(400 000)	unknown
	Eneabba	(400 000)	0	0	(400 000)	unknown
	Lesueur	1 400 000	0	0	1 400 000	water available
	Leederville – Parmelia	(100 000)	0	0	(100 000)	unknown
	Surficial	2 500 000	0	350 000	2 150 000	water available
	Fractured rock	Not applicable	0	240 000	Not applicable	unknown
	Yarragadee	(200 000)	0	0	(200 000)	unknown
Dongara	Cattamarra	(200 000)	0	0	(200 000)	unknown
	Superficial	8 000 000	0	370 000	7 630 000	water available
	Yarragadee	4 500 000	0	750 000	3 750 000	water available
Eneabba Plains	Cattamarra	(100 000)	0	0	(100 000)	unknown
	Eneabba	2 000 000	0	0	2 000 000	limited water available
	Lesueur	1 800 000	0	0	1 800 000	water available
	Superficial	14 600 000	0	130 000	14 470 000	water available
	Surficial	(0)	0	0	(0)	unknown
	Yarragadee	22 500 000	1 000 000	260 000	21 240 000	limited water available
Mingenew	Otorowiri	(100 000)	0	0	(100 000)	unknown
	Leederville – Parmelia	8 200 000	2 000 000	40 000	6 160 000	water available

Table 1 Continued
Groundwater allocation limits and water available for licensing

Resource		Allocation limit ¹ kL/yr	Unlicensed components		Licensable component	Status of water availability for licensing ²
Subarea	Aquifer		Public water supply reserve kL/yr	Exempt unlicensed kL/yr	General licensing kL/yr	
Morrison	Otorowiri	(100 000)	0	0	(100 000)	unknown
	Leederville - Parmelia	4 000 000	500 000	60 000	3 440 000	water available
	Yarragadee	1 000 000	0	0	1 000 000	water available
Tathra	Cattamarra	(50 000)	0	0	(50 000)	unknown
	Eneabba	(100 000)	0	0	(100 000)	unknown
	Lesueur	(100 000)	0	0	(100 000)	unknown
	Leederville - Parmelia	33 400 000	2 000 000	810 000	30 590 000	water available
	Surficial	(0)	0	0	(0)	unknown
	Yarragadee	700 000	0	0	700 000	water available
Twin Hills	Cattamarra	500 000	0	0	500 000	water available
	Eneabba	(400 000)	0	0	(400 000)	unknown
	Lesueur	(200 000)	0	0	(200 000)	unknown
	Otorowiri	(100 000)	0	0	(100 000)	unknown
	Leederville - Parmelia	3 400 000	0	0	3 400 000	water available
	Yarragadee	48 800 000	5 000 000	970 000	42 830 000	water available
	Surficial	600 000	0	110 000	490 000	water available
Total		189 250 000	18 500 000	4 390 000	166 360 000	

1 Allocation limits shown in brackets are an estimate only. Applications to obtain water from these aquifers will require a comprehensive hydrogeological investigation before the water can be allocated. Contact the Mid West Gascoyne regional office in Geraldton for more information.

2 The resource status for licensing is the amount of water available for licensing as of April 2010. Water available = ≤ 70% allocated, no water available = ≥ 100% allocated, limited = ≥ 70% allocated, unknown applies to resources with an estimated volume of water available for licensing as the current capacity of the resource is unknown.

Chapter four

Allocation and licensing policies

Water licences are the regulatory instrument the department uses under the *Rights in Water and Irrigation Act 1914* to manage individual take and use. Allocation plans contain positions to address water allocation and licensing issues in the plan area and direct the assessment and conditions of licences.

The department uses relevant policies to assess licence applications and direct water take and use where water users legally require a licence.

4.1 Approach to allocating water

The objectives set out in Section 2.1, provide the structure for the department's approach to allocating water in the Arrowsmith groundwater area. They are designed to maintain the sustainability of the groundwater resources while maximising water use.

The department uses the licensing process to share the available water, up to the allocation limits set in Section 3.1.

The department applies the first-in first-served approach to assessing applications for a water licence. Where a resource approaches the allocation limit, (generally where less than 30% of the licensable component remains to be allocated for licensing) the department may consider alternative mechanisms to the first-in first-served approach.

The alternative mechanisms to the first-in first-served approach will be applied at the department's discretion, using one of the following approaches:

- merit select
- sale, auction or tender process
- other methods as determined by the department.

We will provide justification for our choice of a particular mechanism in our correspondence with existing and prospective licensees and where any additional work is required to apply for a licence.

We will announce (by advertising or listing on the department's website) the process to be used and the volume of water to be allocated. The announcement will:

- provide directions to interested parties on how to apply for the water
- specify the timeframe in which an application should be submitted
- specify the redistribution mechanism that will be used.

Recouping unused groundwater entitlements

In the Arrowsmith groundwater area the department recoups unused portions of licensed entitlements in accordance with *Statewide policy no. 11 – Management of unused licensed water entitlements* (WRC 2003b).

The department returns the recouped volume of water to the general licensing pool to be redistributed through the licensing process, except for resources that are over-allocated or where trading has commenced.

In areas that are over-allocated the department will not re-allocate the recouped water until the resource returns to below full allocation.

In areas where trading has begun, the recouped volume of water may be re-allocated using one of the alternative mechanisms listed above.

4.2 Groundwater licensing

4.2.1 Legislative requirements

Water users in the Arrowsmith groundwater area may require a water licence to lawfully take groundwater from a well under section 5C of the *Rights in Water and Irrigation Act 1914*. The granting of a water licence is at the department's discretion. We always consider the sections of Clause 7 (2) of Schedule 1 of the *Rights in Water and Irrigation Act, 1914* in exercising this discretion.

Clause 15 of Schedule 1 of the *Rights in Water and Irrigation Act 1914* enables the department to include terms, conditions and restrictions to licences. Conditions may refer to attachments or other documents that the licence must abide by.

Clause 24 (1) of Schedule 1 in the *Rights in Water and Irrigation Act 1914* specifies the department's requirements for altering any licence condition and Clause 26 covers the rights of licensees. Any decision made on a licence application can be appealed through the State Administrative Tribunal (SAT).

The department has developed the policies in Section 4.3 to provide further detail and direction associated with licence conditions.

Exemptions

Private domestic water supply from the watertable (unconfined) aquifer is managed through the Rights in Water and Irrigation Act Exemption and Repeal (Section 26C) Order 2007, and *Strategic policy no. 2.03 – Managing unlicensed groundwater use* (DoW 2009i). The taking of groundwater from the watertable aquifer in the Arrowsmith groundwater area is not licensed where it is used for:

- fire fighting purposes
- watering of stock, other than those raised under intensive conditions
- domestic garden and lawn irrigation (not exceeding 0.2 ha).

The Rights in Water and Irrigation Exemption (Dewatering) (Section 26C) Order 2005 applies in the Arrowsmith groundwater area. This order exempts small short-term dewatering projects.

4.2.2 Approach to licensing groundwater

A water licence provides a legal and secure access to water. The department uses water licences to manage water take and use at an individual scale to:

- protect other users
- protect water-dependent ecosystems
- support economic growth.

4

Allocation and licensing policies

The department undertakes the licensing process in accordance with the requirements of:

- the *Rights in Water and Irrigation Act 1914*
- the strategic and operational policies that apply statewide
- local policies that apply to the plan area.

Auditing licensed use

The department carries out regular licence compliance audits to ensure that water abstraction and use is in accordance with licences and their conditions. During auditing, the department reviews monitoring data and metering data and assesses whether there are any local impacts, to ensure that the licence conditions are appropriate for that particular abstraction.

Fit-for-purpose use of groundwater

Industries that can use lower-quality groundwater should be matched with appropriate lower-quality sources, providing that the impacts of use are in accordance with this plan. In areas of limited groundwater availability, alterations to proposals may be required to allow the use of lower quality water such as high nutrient, saline, recycled water or dewater.

Public water supply reserves

The department has reserved water for public water supply (see Table 1). The highest priority for use of this water is to meet the future regional drinking water supply needs in Mid West towns.

All information submitted by a licensed water service provider as part of a source development plan is used by the department to assess and adjust, where appropriate, the reserve volume for public water supply.

The department will only temporarily allocate reserved water for another purpose if there is no evidence that the reserve is needed for public water supply in a ten-year time frame.

Moving water between management areas

The department generally supports the movement of groundwater (piping or transport of water) between management areas (groundwater area, subarea or plan area) when there is a deficit of water supply in an area that requires water to meet state development commitments. Applications to move water outside a management area will be assessed using the normal licensing process and must be consistent with the objectives and policies in this plan.

Trading (water entitlement transactions)

Where a groundwater resource becomes fully allocated, new applications for water will only be considered if the water is made available through water entitlement transactions (trading, transfer or leasing) from existing licensees in accordance with *Operational policy no. 5.13 – Water entitlement transactions for Western Australia* (DoW 2010d).

4.3 Licensing policies

4.3.1 Policies that apply statewide

The department’s statewide strategic and operational policies apply to the Arrowsmith groundwater area. Table 2 outlines the main strategic and operational policies that apply to the Arrowsmith groundwater area. They are listed by published date. An updated list can be found on our website: www.water.wa.gov.au Doing business with us > Water licensing>.

Table 2

Main strategic and operational policies that apply to the Arrowsmith groundwater area

Policy	Points to note
<i>Statewide policy no. 11 – Management of unused licensed water entitlements</i> (WRC 2003a)	To maximise development opportunities, the department may recoup portions of licensed entitlements that are consistently unused.
<i>Strategic policy no. 5.03 – Metering the taking of water</i> (DoW 2009e) <i>Guidelines for water meter installation</i> (DoW 2009f) <i>Rights in Water and Irrigation (Approved Meters) Order 2009</i>	Outlines the department’s position on metering the taking of water in Western Australia. The policy also documents the updated metering thresholds that trigger the implementation of metering for individual licensees.
<i>Operational policy no. 5.12 – Hydrogeological reporting associated with a groundwater well licence</i> (DoW 2009f)	Describes: <ul style="list-style-type: none"> hydrogeological information the department may request from the licence applicant to complete the assessment of the licence application when and where monitoring bores may be required the structure of monitoring reports that the licensee may be required to regularly submit to the department. This policy applies all to applicants requesting water from a fractured rock resource and for dewatering purposes.
<i>Operational policy no. 5.11 – Timely submission of required further information</i> (DoW 2009g)	Describes how the department manages the time lines that a licensee has for submitting any additional requested information as part of their licence application.
<i>Operational policy no. 1.2 – Policy on water conservation and efficiency plans: achieving water use efficiency gains through water licensing</i> (DoW 2009h)	Under this policy the department may require water use efficiency plans to be implemented by licensees.

Table 2 Continued

Main strategic and operational policies that apply to the Arrowsmith groundwater area

Policy	Points to note
<i>Operational policy no. 5.13 – Water entitlement transactions for Western Australia, (DoW 2010d)</i>	This policy contains the department’s rules for a trade, transfer or lease of all, or part of, a licence’s water entitlement.
<i>Operational policy no. 5.08 – Use of operating strategies in the water licensing process 2010e)</i>	Describes: <ul style="list-style-type: none"> • which water licence applicants are likely to require operating strategies • how operating strategies form part of the conditions of a water licence • how licence applicants should develop an operating strategy • the licensee’s responsibilities in complying with an operating strategy.
<i>Guidelines for assessing the potential impacts on groundwater-dependent ecosystems when applying for a groundwater licence (DoW 2010b)</i>	These guidelines are used in conjunction with <i>Operational policy no. 5.12</i> to determine a licensee’s requirements where the application is likely to affect a groundwater-dependent ecosystem.

4.3.2 Local licensing policies for the Arrowsmith groundwater area

The local licensing policies that apply to the Arrowsmith groundwater area are set out in Table 3. Local policies complement the department’s statewide strategic or operational policies. The local policies take precedence over statewide policies if there is an inconsistency between them.

Table 3
Licensing policies that apply to the plan area

Group	Policy
1 Groundwater licensing and water use	
1.1 Stock and domestic use	1.1.1 Applications for domestic bores (in-house and garden use) from a confined aquifer will be refused where there is an alternative water supply, unless there are extenuating circumstances. Alternative water supply options include: <ul style="list-style-type: none"> • the unconfined aquifer • scheme water • private rainwater tanks.
	1.1.2 Aquaculture is considered as stock raised under intensive conditions in the Arrowsmith groundwater area and hence it is not exempt from licensing.
1.2 26D licence conditions on bore construction	1.2.1 Applications for bores to be drilled into the Cattamarra, Eneabba, Lesueur, Parmelia or Yarragadee aquifers deeper than 50 m below ground level or for a volume > 500 000 kL/yr require submission of <ul style="list-style-type: none"> • a detailed description of the lithology • survey level of bore • geophysical logs. Additionally palynology analysis may also be required for these aquifers where they are in a recharge area.
	1.2.2 The department may request the applicant to relocate the proposed site for drilling a new bore to manage the spatial distribution of the draw from an aquifer.
1.3 Operating strategies	1.3.1 In addition to the requirements of <i>Operational policy no. 5.08 – Use of operating strategies in the water licensing process</i> (DoW 2010e) all new groundwater licences require an operating strategy where they are: <ul style="list-style-type: none"> • requesting groundwater as part of a state agreement • requesting to access a public water supply source (see Section 4.2.2 and policy 3.1) • applying to move water (see policy 1.4) • abstracting groundwater as part of a licensable dewatering activity that is likely to affect an existing user or the environment.
	1.3.2 Contingency options for back-up water supplies, emergency situations or drought proofing related to a licence application should be included in the operating strategy.

Table 3 Continued
Licensing policies that apply to the plan area

Group	Policy
<p>1.4 Moving water between management areas</p>	<p>1.4.1 Moving water between management areas is only acceptable where:</p> <ul style="list-style-type: none"> • there is no local water supply that is suitable for meeting the demand in the delivery area • all reasonable measures for reducing water demand in the delivery area have been undertaken by the applicant • any water quality and level issues associated with the movement, use or disposal of the water in the delivery and source area are addressed • the environment, existing users and the local community of the source area will not be unacceptably affected. <p>1.4.2 Depending upon the scale and scope of an application to move water out of a management area the licence applicant may be required to:</p> <ul style="list-style-type: none"> • advertise their intention to move water between areas in both state and local newspapers • consult the communities from the source area who are likely to be affected (see policy 1.5) • submit a project description (see policy 1.6) • submit a hydrogeological report, which should include: <ul style="list-style-type: none"> - evidence that there is insufficient water available in the area the water is to be moved to - proof that the proposed volume of water can be sustainably abstracted from the water source • submit an operating strategy, which should include: <ul style="list-style-type: none"> - how any environmental impacts identified will be managed (at both the source and delivery area) - contingency options for back-up supplies if the supply at the source is altered - exit strategies if the supply is no longer needed.
<p>1.5 Public consultation associated with a groundwater licence</p>	<p>1.5.1 A public consultation process may be required if an application is submitted for a licence that:</p> <ul style="list-style-type: none"> • requires > 1 000 000 kL/yr • involves the movement of water out of a subarea or over a distance of more than 100 km (see policy 1.4). <p>Applicants required to undertake community consultation as part of another agency's approvals process may be granted an exemption, where the consultation has included water as part of the development proposal.</p> <p>1.5.2 Applicants required to undertake a public consultation process should submit the following documentation to the department:</p> <ul style="list-style-type: none"> • a public consultation plan (prior to commencing consultation) • a public consultation report (following completion of the consultation) identifying: <ul style="list-style-type: none"> - all issues raised during the consultation process - documentation of the public meetings held and submissions received - a summary of any social or cultural research undertaken - a summary of the potential effect on the community (e.g. on recreational areas, water use, lifestyle) - a summary of outcomes from any economic analysis or feasibility study undertaken.

Table 3 Continued
Licensing policies that apply to the plan area

Group	Policy
1.6 Project descriptions associated with a water licence	<p>1.6.1 A project description may be required for groundwater licence applications requesting:</p> <ul style="list-style-type: none"> • >1 000 000 kL/yr and/or • any volume of water to be moved out of a management area (see policy 1.4). <p>Applicants may be granted an exemption from providing this information if they already hold a valid groundwater licence or the requested volume of water is associated with an existing development.</p> <p>1.6.2 Depending upon the scale and scope of the application and the information contained in the project description an applicant may be required to carry out community consultation as per policy 1.5.</p>
2 Environmental policies	
2.1 Water level criteria	<p>In areas where the department has defined water level criteria or trigger levels for a specific site, the department may:</p> <ul style="list-style-type: none"> • restrict abstraction (e.g. timing, rate of abstraction) • require production bores to be located away from these sites • require the development of operating strategies with monitoring programs.
2.2 River baseflow systems	<p>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:</p> <ul style="list-style-type: none"> • request the undertaking of hydrogeological studies • require relocation of the proposed draw point away from the river • restrict the volume of water drawn during a particular time period.
2.3 Saltwater interface	<p>Groundwater abstraction from the Superficial aquifer adjacent to the coast may be restricted to minimise the risk of moving the saltwater interface. The department may require licensees to construct and monitor bores if their abstraction is likely to result in the interface moving inland.</p>
3 Public water supply	
3.1 Accessing the public water supply reserve for other purposes	3.1.1 Water from the public water supply reserve will only be allocated for a maximum of ten years and cannot be traded. The licence will be non-renewable.
	3.1.2 A maximum of 75 % of the volume of a public reserve can be temporarily allocated at any one time for each resource.

4.3.3 Additional information for groundwater users

Alternative water supplies

In groundwater areas where all the available resources have been allocated, applicants should consider the use of alternative supplies such as recycled wastewater, drainage and stormwater re-use, desalination or managed aquifer recharge to meet their water requirements. The department may be contacted to discuss any allocation or licensing issues where alternative sources are part of a licence application.

Public consultation associated with a groundwater licence

Licensees requesting guidance for developing and completing public consultation associated with a licence application can contact the department's Mid West Gascoyne regional office in Geraldton.

All consultation processes associated with a groundwater licence should be conducted in the presence of a representative from the department.

Information from public consultations is used to assess the application and produce a statement of response to any submissions received from the public. The statement of response will be sent to the licence applicant and those who made submissions, upon completion of the assessment process.

As part of our licensing process the department will only refer licence applications to other government agencies for advice on technical information outside the department's area of expertise.

Project descriptions associated with a groundwater licence

Licensees requesting guidance for developing and completing a project description document associated with a licence application can contact the department's Mid West Gascoyne regional office in Geraldton for more information.

A project description document may include:

- a project description, including a detailed description of the water use activity
- a development timetable if the project is to be developed over several years
- a statement of how water use will be managed including any:
 - water efficiency mechanisms
 - efficiency targets
 - summary of water balance options for water recycling and reuse
- a summary of any site investigations or studies done to date, including:
 - hydrogeological reports
 - feasibility study or economic analysis
 - environmental studies
 - community consultation.

The aim of this information is to ensure that the water requested is in the interests of the whole community and will be used efficiently.

Information submitted should not contain confidential or commercially

sensitive information, since all material submitted to the department can be requested through the freedom of information process.

Dewatering

Water users undertaking dewatering should consult the following documents to ensure the risks of these activities are minimised:

- *Better managing the urban water cycle - the urban drainage initiative* (DoW 2007)
- *Better urban water management* (WAPC 2008)
- *Mining and mineral processing, Water quality protection guidelines numbers 1-11* (WRC 2000)
- *Dewatering of soils at construction sites, Water quality protection note no. 13* (DoW 2010e).

Domestic bore use

The unconfined (watertable) aquifers in the Arrowsmith groundwater area have patches of poor water quality and are usually low yielding. If a domestic bore is required please contact the department to check if this aquifer is suitable, or for alternative options.

The department does not recommend drinking bore water in the Arrowsmith groundwater area. If groundwater is used for private drinking water supplies, it is advisable to filter, treat and test the water according to public health advice from the Department of Health. Also see the department's water quality protection notes, *Australian drinking water guidelines 2004* (Australian Government 2004) and the *Australian fresh and marine water quality guidelines* (ANZECC & ARMCANZ 2000) for more information.

Chapter five

Monitoring program

5.1 Program description

The department uses the monitoring bores in the state reference network in the Arrowsmith groundwater area to assess the performance of the various aquifers and to check that groundwater abstraction is sustainable.

The current monitoring bore network in the Arrowsmith groundwater area consists of 168 bores (Table 4; Figure 4 and Figure 5). The monitoring bores have been used to record changes in water level since the mid 1970s.

Water quality sampling at a regional scale has not been conducted since the monitoring bores were constructed.

Table 4
Department of Water monitoring bores in the Arrowsmith groundwater area

Monitoring bore series ¹	Aquifer						Total
	Superficial, surficial and fractured rock	Leederville – Parmelia	Yarragadee	Cattamarra	Eneabba	Permian Sandstone	
Allanooka-Irwin (Irwin view)	1	0	19	0	0	0	20
Arrowsmith scheme	0	0	17	0	0	1	18
Dongara line (DL)	0	1	8	0	0	0	9
Eneabba line (EL)	1	6	15	2	3	0	27
Greenough shallow (GS)	16	0	4	4	0	0	24
Leeman shallow (LS)	12	0	23	1	/5	0	41
Yarra Yarra Lakes (YR)	25	0	1	0	3	0	29
TOTAL	55	7	87	7	11	1	168

¹ Monitoring bore series short name, listed in brackets, refers to the naming of the bores in Figure 5. The Arrowsmith scheme monitoring bores are currently being updated in the monitoring system and so they are not shown on Figure 5.

5.2 Current program

Water level measurements from monitoring bores are the main source of information about the hydraulic stresses acting on aquifers and how they affect groundwater recharge, storage and discharge. This is particularly important in the Arrowsmith groundwater area given the high likelihood of increased abstraction.

As part of the current monitoring program, the department measures water levels twice a year – once at the end of summer and once at the end of winter. We use the information collected through the groundwater monitoring network to assess the groundwater resources, including water level and quality trends (Table 7).

This assessment help us to:

- review licence conditions
- review regional and local impacts on the groundwater resource
- assess performance against the plan's objectives to evaluate the plan (Section 6.2).

The department may request that licensees install private monitoring bores where abstraction has the potential to affect groundwater-dependent ecosystems and other users at a local scale.

5.3 Review of the monitoring program

The department will review the current monitoring program as part of implementing this plan. The review will assess whether the monitoring program supports the needs of this plan to:

- meet the objectives of this plan (Section 2.1)

- measure performance indicators (Section 6.2)
- evaluate whether our approach is appropriate for managing the groundwater resources.

The review of the monitoring program will take place after the investigations into groundwater-dependent ecosystems and social and cultural water requirements in 2011 have been completed (see Table 5).

The review will:

- assess whether the frequency of water level measurements in all aquifers is adequate
- assess whether the frequency of water quality measurements are adequate to monitor the saltwater interface along the coast, particularly near Dongara
- identify areas where new bores may be required to monitor critical features such as the saltwater interface and groundwater-dependent ecosystems
- recommend any changes, including priorities for measurement for this plan.

The revised monitoring program will:

- determine criteria sites for monitoring groundwater-dependent ecosystems
- set the critical levels for the criteria sites.
- specify what groundwater quality measurements are required and where. This includes identifying which analytes to be monitored.

During the review of the monitoring program any monitoring associated with implementing the plan will be included in the changes. This program will be updated as required in accordance with any relevant changes in the plan.

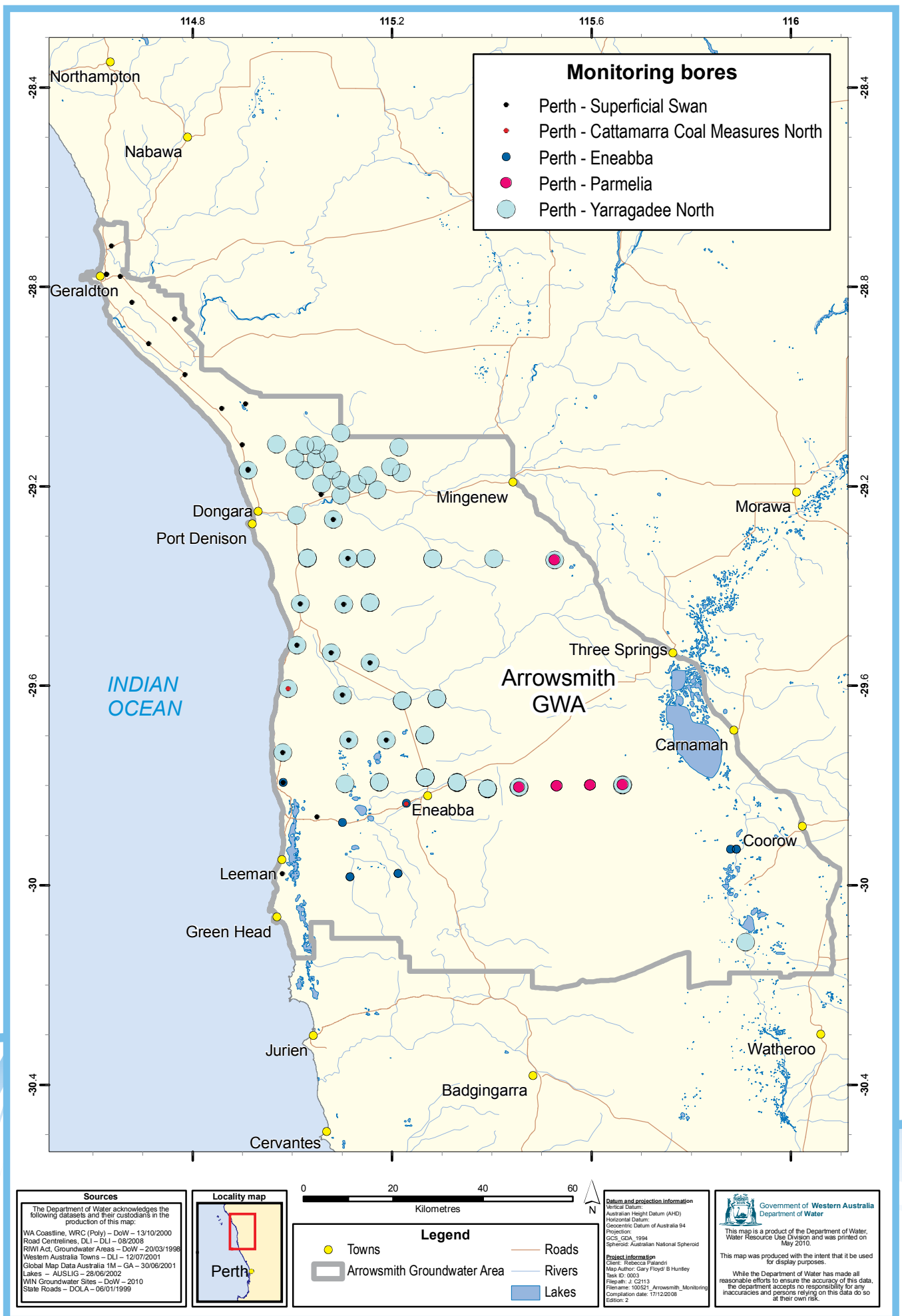


Figure 4
 The department's monitoring bores by aquifer in the Arrowsmith groundwater area
 Arrowsmith groundwater allocation plan

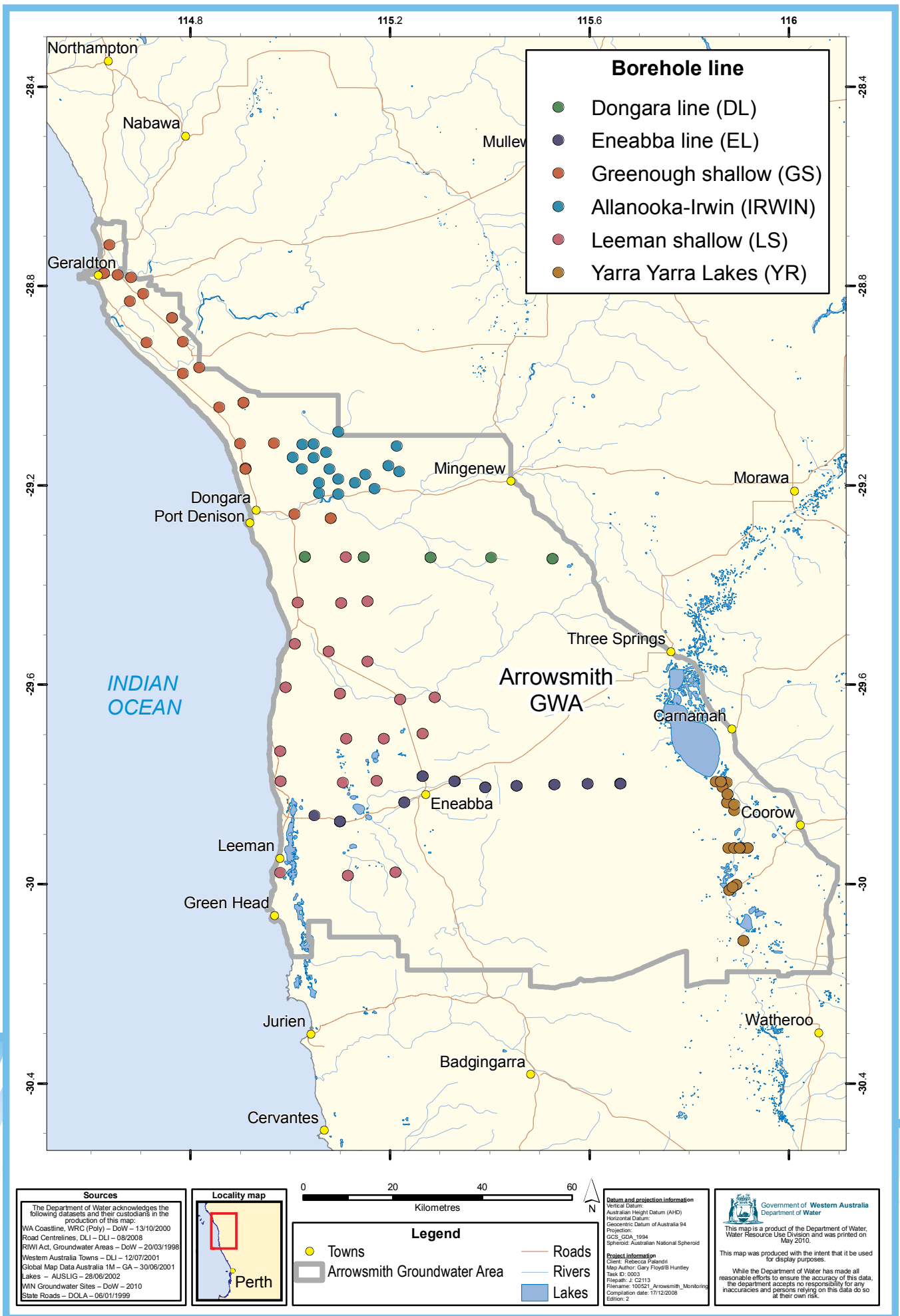


Figure 5
 The department's monitoring bores by borehole line in the Arrowsmith groundwater area

Chapter six

Implementing and evaluating the plan

This section describes how the department will implement, evaluate and review the *Arrowsmith groundwater allocation plan*.

6.1 Implementing the plan

We have committed to a list of actions that will enable us to implement this plan (Table 5) and improve planning in the future (Table 6). We have developed these actions by:

- identifying the gaps in our current knowledge and information
- reviewing current management arrangements
- assessing what information we need for future planning.

Table 5
Actions for implementing this plan

Action	Responsibility ¹	Timeline	
Resource assessment			
1	Assess the condition and performance of the groundwater resources.	Water Resource Assessment	Annually
Monitoring			
2	Review, and amend where appropriate, the current groundwater monitoring program.	Water Resource Assessment and Mid West Gascoyne region	2011
3	Develop appropriate threshold levels for groundwater levels at groundwater-dependent criteria sites .	Water Allocation Planning	2011
Licensing			
4	Review the reserved allocations for public water supply.	Water Allocation Planning and Mid West Gascoyne region	Every five years from release of the plan or when > 50% of the current reserve is licensed to a water service provider
Communication and evaluation statement			
5	Release an annual evaluation statement on the plan and its implementation.	Mid West Gascoyne region and Water Allocation Planning	Annually

1 Departmental branch responsible for the action.

Table 6
Actions for future planning

Action	Responsibility ¹	Timeline	
Resource assessment			
6	Review and update the hydrogeological knowledge of the Northern Perth Basin following completion of current groundwater investigations and modelling.	Water Resource Assessment	2012
7	Investigate representative groundwater-dependent ecosystems and their water requirements for the review of this plan.	Water Allocation Planning	2012
8	Investigate social and cultural values of groundwater-dependent ecosystems for the review of this plan.	Water Allocation Planning	2011

1 Departmental branch responsible for the action.

6.2 Evaluating and reviewing the plan

Table 7 summarises the performance indicators that we will use to measure the performance of this plan against its objectives.

Table 7
Performance indicators to measure the plan's performance

Performance indicator	Objectives	How will we assess it?
Maintain groundwater levels in high use (>70% allocated) areas	a and b	<ul style="list-style-type: none"> Review spatial distribution of production bores and groundwater level data to determine if local or regional abstraction is causing any impacts Review licensees' annual monitoring reports Minimum groundwater levels in monitoring bores in unconfined or connected aquifers (provide baseflow to surface water features and/or support groundwater-dependent ecosystems) do not continuously decline by more than 0.1 m/yr over three years
Minimise movement of saltwater interface	c	<ul style="list-style-type: none"> Review groundwater salinity data collected from licensee and department monitoring bores along the coast in the Superficial aquifer to determine if local or regional abstraction is causing any impacts Review licensees' annual monitoring reports
Groundwater is allocated to within the allocation limits	a, b and d	<ul style="list-style-type: none"> Compare changes in the amount of water licensed for different use categories across each resource over time Compare the volume of water licensed against the allocation limit (general licensing component) for each resource Compare the volume of water moved for use outside of a management area with the total volume of water licensed for use within the same management area Report on the volume of unused water entitlements recouped

Table 7 Continued
Performance indicators to measure the plan's performance

Performance indicator	Objectives	How will we assess it?
Volume of water abstracted is less than or equal to the volume of licensed water entitlements	a, b and d	<ul style="list-style-type: none"> • Compare licensees' metered use against the volume of water licensed • Licensee metering reports show use is not more than 10% over the licensed entitlement • Review licensees' annual reports to assess whether water efficiency targets are being met

The department will release an annual evaluation statement each year to identify whether the plan is achieving its objectives and meeting the performance indicators. To prepare the statement we will:

- assess the allocation status for each resource and compare it with previous years
- summarise the status of actions required by the plan in the evaluation period
- assess the status and trends of the groundwater resources
- assess performance against the plan objectives
- assess if there is a need to amend or replace the plan.

The annual evaluation statement will be publicly released and available on the department's website or by contacting the Mid West Gascoyne regional office in Geraldton.

Appendices

Arrowsmith groundwater allocation plan

A

Appendix A Summary of the hydrogeology in the Arrowsmith groundwater area

The Arrowsmith groundwater area is located in the coastal mid-west of Western Australia and contains significant groundwater resources that are stored in a thick succession of sedimentary aquifers. It is part of the Northern Perth Basin which extends from Geraldton (in the north) to Gingin (in the south). The Darling Fault between Gingin and Mullewa marks the eastern boundaries of the basin.

Most knowledge of the hydrogeology in the Arrowsmith groundwater area has been acquired through regional groundwater investigations by the Geological Survey of Western Australia between 1963 (Arrowsmith scheme) and 1994 (Greenough shallow series).

This hydrogeological summary of the Arrowsmith groundwater area has been compiled from the reports on these investigations as well as subsequent investigations carried out in the mid 1990s by the Water and Rivers Commission. These reports include regional groundwater investigations

and geology and structural reports based upon drilling and geophysical work. Many of the bores drilled as part of these investigations form the basis of the regional monitoring network (see Section 5).

The physiography and sub-crop geology of the Arrowsmith groundwater area are presented in Figures A1, A2 and A3. The figures show where the physiography units and geological formations are located. A conceptual geological cross-section (Figure A3) has been included to show the depth, location and layering of aquifer formations across the Arrowsmith region from the area just north of Leeman to near Coorow.

Table A1 presents the groundwater salinity threshold categories used in Tables A2 and A3. Tables A2 and A3 contain a brief summary of the unconfined and confined aquifer systems respectively, that are present in the Arrowsmith groundwater area.

Table A1
Groundwater salinity threshold categories (DoW 2009f)

Salinity type	TDS range mg/L
Fresh	< 500
Marginal	501-1500
Brackish	1 501-5 000
Saline	5 001-50 000
Hypersaline	> 50 000

Table A2
Summary of unconfined aquifer systems

Aquifer	Formation	Groundwater subarea and location	Estimated bore yields ¹	Groundwater quality ²
Superficial	Safety Bay Sand	Dongara Knobby Head to Green Head – Coastal Belt	Generally small supply < 100 kL/day	Generally fresh-brackish. Salinity increasing with depth
		Dongara From Cliff Head to Port Denison – Coastal Belt	Generally small supply < 100 kL/day	Marginal-brackish, affected by presence of saltwater interface, salinity increasing with depth. Thin 'fresh' groundwater horizon overlying brackish groundwater
		Dongara From Port Denison to Geraldton – Coastal Belt	Generally small supply < 100 kL/day	Generally fresh-brackish. Salinity increasing with depth. Fresh groundwater supply restricted to extent of rainfall recharge
	Tamala Limestone	Dongara From Green Head to Coolimba – Coastal Belt	Generally small to moderate < 250 kL/day	Generally brackish-saline
		Dongara From Coolimba to Cliff Head – Coastal Belt	Largely unsaturated	Generally brackish-saline
		Dongara From Cliff Head to Geraldton – Coastal Belt	Small to moderate < 250 kL/day	Generally brackish-saline. Groundwater quality in vicinity of Greenough River will be brackish
	Bassendean Sand	Dongara across to Eneabba Plains	Small to moderate	Marginal-brackish, salinity increasing towards Gingin (Eneabba Scarp)
Surficial	Surficial sediments	Twin Hills In the Arrowsmith Region	Generally small supply < 100 kL/day	Marginal-brackish
		Mingenew, Tathra and Morrison on the Dandaragan Plateau	Generally small supply < 100 kL/day	Marginal-brackish
		Darling In the Yarra Yarra Region	Generally small supply < 50 kL/day	Marginal-brackish
	Palaeochannels	Mingenew, Tathra, Darling on the Darling Plateau	Variable	Marginal-brackish
Fractured rock	Proterozoic rocks – Yilgarn	Darling East of the Darling Fault to the Darling Plateau	Generally small < 50 kL/day	Marginal-brackish
Permian	Mullingarra Inlier east of the Urella Fault	Darling (in the north) and Tathra (along the north-eastern edge)	Generally small < 200 kL/day	Marginal-moderately saline

1 Bore yields represent an estimation of likely sustainable groundwater abstraction. Bore yields may vary due to local characteristics and groundwater recharge potential.

2 See Table A1 for groundwater salinity threshold categories.

A

Appendix A Summary of the hydrogeology in the Arrowsmith groundwater area

Table A3
Summary of confined aquifer systems

Aquifer	Formation	Groundwater subarea and location	Estimated bore yields ¹	Groundwater quality ²
Leederville - Parmelia	Parmelia	Mingenew, Tathra and Morrison	Moderate supplies > 500 kL/day	Commonly fresh - marginal
Yarragadee	Yarragadee	Dongara, Eneabba Plains, Twin Hills, Allanooka, Tathra, Mingenev and Morrison	Large supplies > 1000 kL/day	Commonly fresh - brackish. Saline at Dongara
Cattamarra	Cattamarra Coal Measures	Dongara and Eneabba Plains (in the south)	Moderate supplies > 500 kL/day	Brackish, regional groundwater is limited
		Dongara (north and Greenough Flats)	Moderate supplies > 500 kL/day	Generally brackish; marginal groundwater is limited
		Twin Hills and Allanooka	Moderate supplies > 500 kL/day	Brackish-saline at depth
Eneabba	Eneabba	Dongara and Eneabba Plains.	Moderate 500-1000 kL/day	Fresh-brackish.
Lesueur	Lesueur Sandstone	Dongara and Eneabba Plains.	Large up to 2000 kL/day	Generally fresh-marginal in the outcrop and subcrop areas
Yarragadee, Cattamarra, Eneabba and Lesueur	Yarragadee, Cattamarra Coal Measures, Eneabba and Lesueur Sandstone	Darling southern extent of Yarra Yarra Region	Variable small supplies, commonly < 250 kL/day	Variable, ranges from brackish to saline.

1 Bore yields represent an estimation of likely sustainable groundwater abstraction. Bore yields may vary due to local characteristics and groundwater recharge potential.

2 See Table A1 for groundwater salinity threshold categories.

Water level trends

Monitoring data from departmental and licensee bores is used to assess the change in water levels in an aquifer. The water level trends will vary according to the type of aquifer system, recharge rates and impacts of local and regional abstraction.

Water levels in all aquifers across the groundwater area are generally stable, with levels in several areas increasing. The increase in water levels may be a result of increased recharge in cleared areas (rising watertables east of the groundwater area) or increased recharge in floodplain areas (through cyclonic events). A regional increase in water levels has been observed in the Leederville–Parmelia aquifer and Yarragadee aquifers east of the Eneabba Plains subarea (unconfined area).

There are some areas showing localised declines in water levels, close to abstraction points. This can be seen in some bores in the Dongara and Eneabba subareas in the Superficial, Cattamarra and Yarragadee aquifers. However, as the monitoring has been infrequent in these areas detailed measurements will be required to determine whether these water levels are changing and at what rate.

Groundwater recharge

Recharge to confined aquifer systems occurs via rainfall in areas where the formation outcrops, or is exposed near the surface, and in some cases through leakage from overlying and underlying aquifer systems. In general, recharge to the unconfined aquifers is from direct rainfall infiltration.

Rainfall recharge has been estimated by calculating a percentage of local mean annual rainfall (5–10 percent) that falls over the land area where the soil types allow vertical seepage to occur. There has been no direct measurement of recharge rates in the Arrowsmith groundwater area, hence the current recharge rates are based on extrapolation from estimates elsewhere in the Northern Perth Basin and an understanding of hydrogeological principles. These rates are conservative, and will remain so until new information is available from ongoing and proposed hydrogeological studies of the Northern Perth Basin.

To achieve long-term sustainability of our water resources the department only uses the renewable component in calculating the amount of water that can be sustainably abstracted from any given resource. This ensures that the rate of usage will not be continuously greater than the rate of recharge.

Future investigations

The department has initiated a compilation of all hydrogeological and relevant geological work across the Northern Perth Basin, which will be published as the *Northern Perth Bulletin* in 2011. This work will form the basis for the development of a hydrogeological model that will assist in the understanding of groundwater interactions and the impact of abstraction in the Arrowsmith groundwater area.

A

Appendix A Summary of the hydrogeology in the Arrowsmith groundwater area

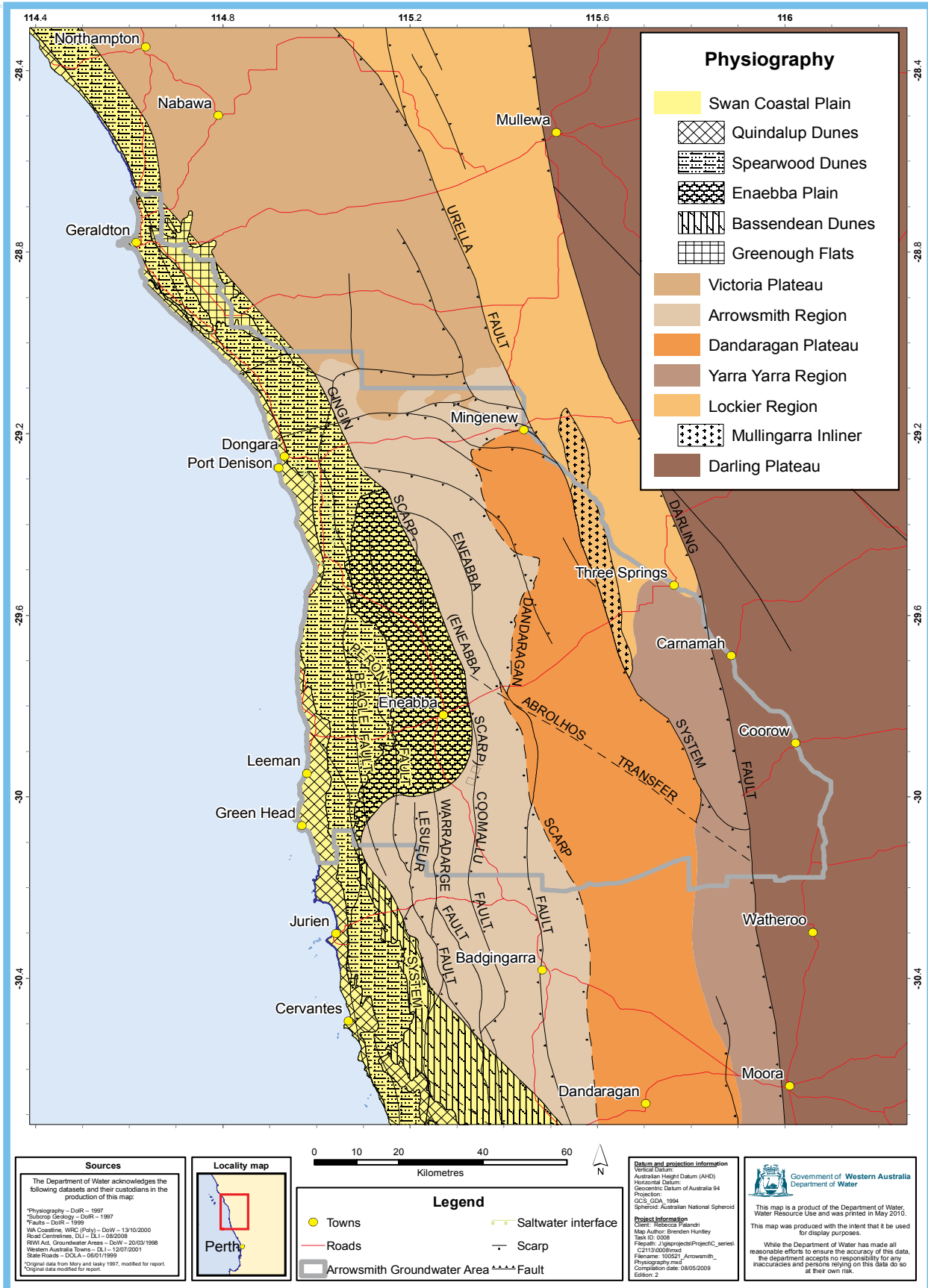


Figure A1
Physiography of the Arrowsmith groundwater area

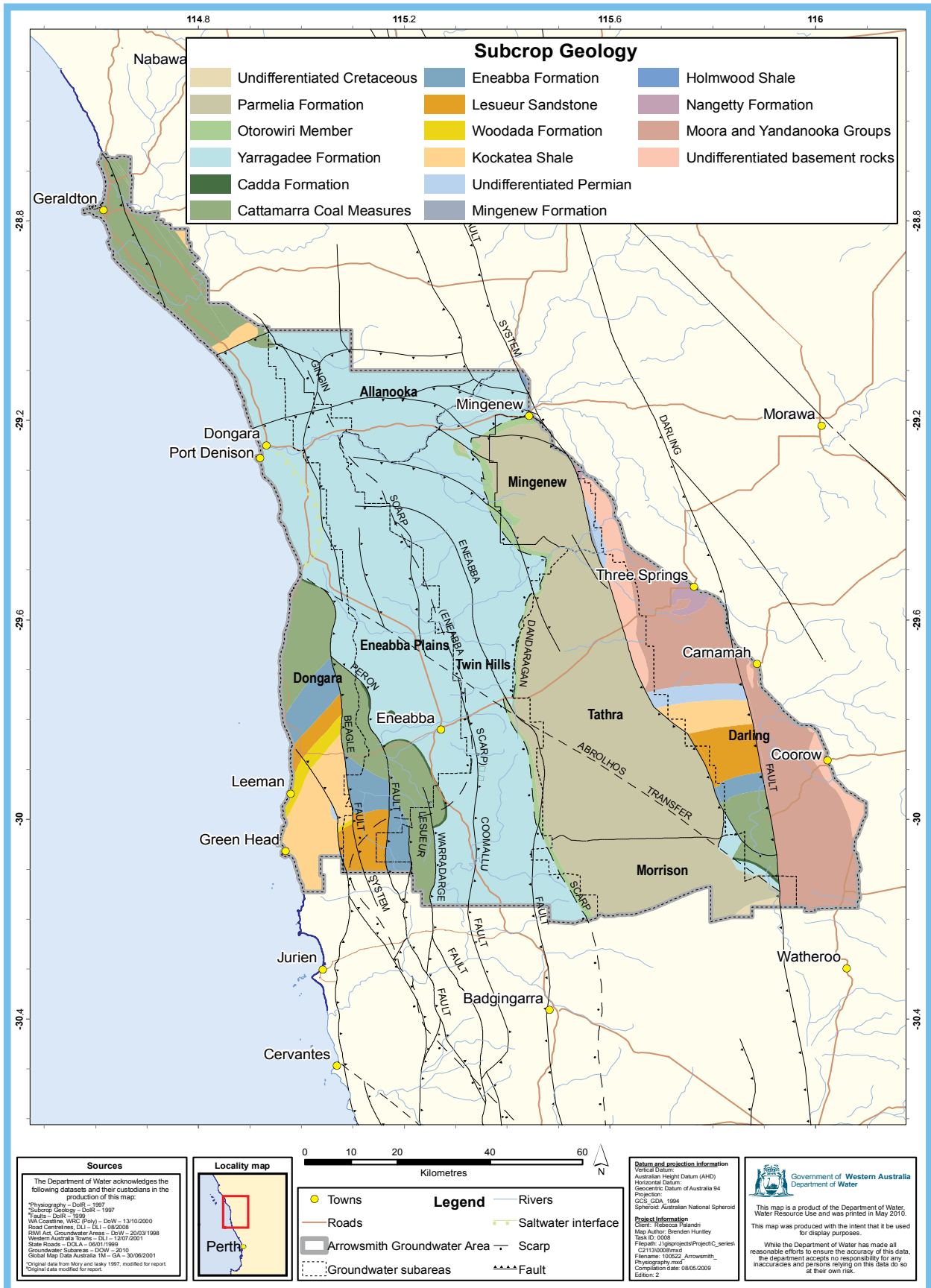


Figure A2
Sub-crop geology of the Arrowsmith groundwater area
Arrowsmith groundwater allocation plan

A

Appendix A Summary of the hydrogeology in the Arrowsmith groundwater area

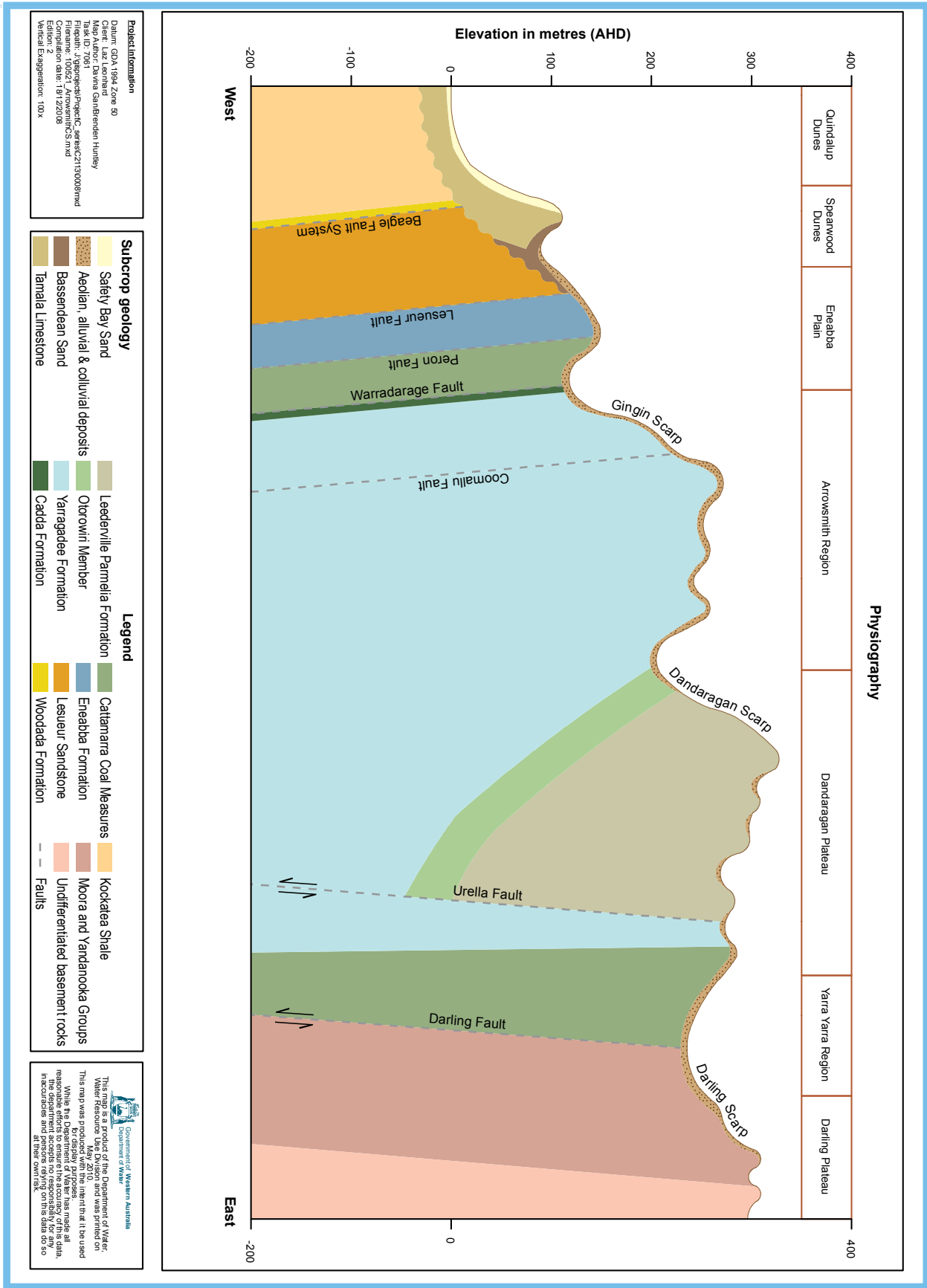


Figure A3
Conceptual geological cross-section of the Arrowsmith groundwater area
Arrowsmith groundwater allocation plan

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.
AHD	Australian height datum – mean sea level at Fremantle + 0.026 m.
Allocation limit	Annual volume of water set aside for licensed and unlicensed use from a water resource.
Aquifer	A geological formation or group of formations capable of receiving, storing and transmitting water.
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.
Baseflow	The component of streamflow 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 <i>Rights In Water and Irrigation Act 1914</i> .
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.
Discharge	The water that moves from the groundwater to the ground surface or above, such as a spring. This includes water that seeps to the ground surface, evaporation from soil, and water extracted from groundwater by plants (evapotranspiration) or engineering works (groundwater pumping).
Domestic bore	A bore used for providing the household 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.
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	The water that occurs in pore spaces and fractures in rocks beneath the ground surface. Also see aquifer, confined and unconfined aquifer.
Groundwater area	An area proclaimed under 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.
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	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.

Glossary

Management area	A proclaimed groundwater area or subarea. See definitions for proclaimed area and subarea for more information.
Moving water	The department defines moving water between proclaimed groundwater area or subarea as the physical transport of water (piping) outside of the area the water was sourced from.
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.
Proclaimed area	An area proclaimed for licensing under the <i>Rights in Water and Irrigation Act 1914</i> .
Public water supply reserve	Reservation of a volume of water, from the allocation limit, to supply drinking water for human consumption.
Recharge	Water that infiltrates into the soil to replenish an aquifer.
Resource	In the Arrowsmith groundwater area a resource is a given aquifer in a particular groundwater subarea.
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).
Subarea	A smaller area determined by the Department of Water in 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.
Surface water	Water flowing over or held in streams, rivers and wetlands on the surface of the land.
Throughflow	The flow of water in an aquifer.
Unconfined aquifer	Is the aquifer nearest the surface, having no overlying confining layer. The upper surface of the groundwater in the aquifer is called the watertable. An aquifer containing 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.
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.
Watertable	The saturated level of the unconfined groundwater. Wetlands in low-lying areas are often seasonal or permanent surface expressions of the watertable.
Water use efficiency	Increasing water supply efficiency and water demand efficiency to minimise the taking and use of water.
Wetland	An area that is permanently, seasonally or intermittently waterlogged or inundated with water that may be fresh, saline, flowing or static (taken from Ramsar Convention definition).
Yield	The volume of water that may be drawn from a well or water supply system.

Shortened forms			
ANZECC	Australian and New Zealand Environmental Conservation Council		
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand		
DoW	Department of Water		
NACC	Northern Agricultural Catchments Council		
TDS	Total dissolved solids		
WAPC	Western Australian Planning Commission		
WAWA	Water Authority of Western Australia		
WRC	Water and Rivers Commission		
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)

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Notes



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