Government of Western Australia
Department of Water

Review of the Jurien and Arrowsmith groundwater

allocation limits : Supporting information for the Jurien and Arrowsmith groundwater allocation plans

Looking after all our water needs

Review of the Jurien and Arrowsmith groundwater allocation limits

Supporting information for the Jurien and Arrowsmith groundwater area allocation plans.

Department of Water

Water resource allocation planning series

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Why is this being done?

The Department of Water is responsible for determining the volume of a water resource that is available for consumptive use and how much is required to maintain the function of the aquifer and support the environment. These decisions are made by setting allocation limits. The allocation limits for the Jurien and Arrowsmith groundwater areas were reviewed and endorsed by the department as part of preparing the new groundwater area allocation plans for these areas.

The allocation limits were previously set in 1995 by the Water Authority (*Jurien groundwater area management plan* and *Arrowsmith groundwater area management plan*) and revised in 2002 by the Water and Rivers Commission (*Managing the water resources of the Jurien groundwater area, WA – interim sub-regional allocation strategy* and *Managing the water resources of the Arrowsmith groundwater area, WA – interim sub-regional allocation strategy*).

The allocation limits set in the 2002 strategies were reviewed for use in the new allocation plans. The review process assessed options in light of current knowledge. This document provides the justification for accepting or changing the previous limits.

What are the results?

For the new Jurien and Arrowsmith groundwater area allocation plans the allocation limits set by the 2002 interim strategies were accepted, with minor changes to some of the sedimentary aquifers whose extent and availability are currently unknown. The limits were also adjusted to factor in estimated exempt (stock and domestic) use for each groundwater subarea and aquifer.

What does this mean?

The allocation limits determined through this document will be presented in the *Jurien groundwater area allocation plan* and the *Arrowsmith groundwater area allocation plan.* These limits have been reviewed in light of current available science and changes to water management practices. The department will manage licensed water use up to these limits in each management area.

1 Introduction

The Department of Water is responsible for deciding how much of a water resource is available for consumptive use and how much remains in the environment. These decisions are reflected by setting allocation limits.

The department sets the allocation limits by a systematic review process. The process considers the sustainable yield of the groundwater resource and sets the amount of water available for consumptive use (licensed and exempt). By doing this, we aim to ensure that the annual abstraction regime does not have unacceptable impacts on water quantity and quality, and on groundwater-dependent ecosystems.

1.1 What is an allocation limit?

An allocation limit is the amount of water assigned for consumptive use for a given water resource, after the needs of the dependent systems are met. The systems' needs include:

- maintaining aquifer integrity
- maintaining groundwater throughflow
- maintaining water quality
- meeting the *in situ* needs of the groundwater-dependent ecosystems
- maintaining the surface water systems connected to the groundwater resource
- meeting the *in situ* needs of the social and cultural water requirements.

Allocation limits are the key mechanism used to manage abstraction within reasonable environmental constraints. Water is allocated through the licensing process up to the allocation limit. Complementary mechanisms such as monitoring, investigations and compliance increase the effectiveness of the allocation limits and minimise the potential impacts of abstraction on the environment and other users.

The allocation limits are set to manage the potential impacts to the environment in the future, while sustaining reasonable growth in the region. Water has been reserved within the allocation limits to ensure that sufficient drinking water supplies are available for local towns to expand, provided this water is used efficiently.

1.2 Allocation units

Allocation limits set through the review process are divided into management units called groundwater subareas (Figure 1 and Figure 2). Each groundwater subarea has a number of aquifers (groundwater resources), with each aquifer assigned an allocation limit. It is important to note that aquifers present often extend outside an allocation unit or groundwater subarea. The subarea boundaries and aquifer shapes for each groundwater area were not amended during the review process.

Figure 1 Arrowsmith groundwater subareas

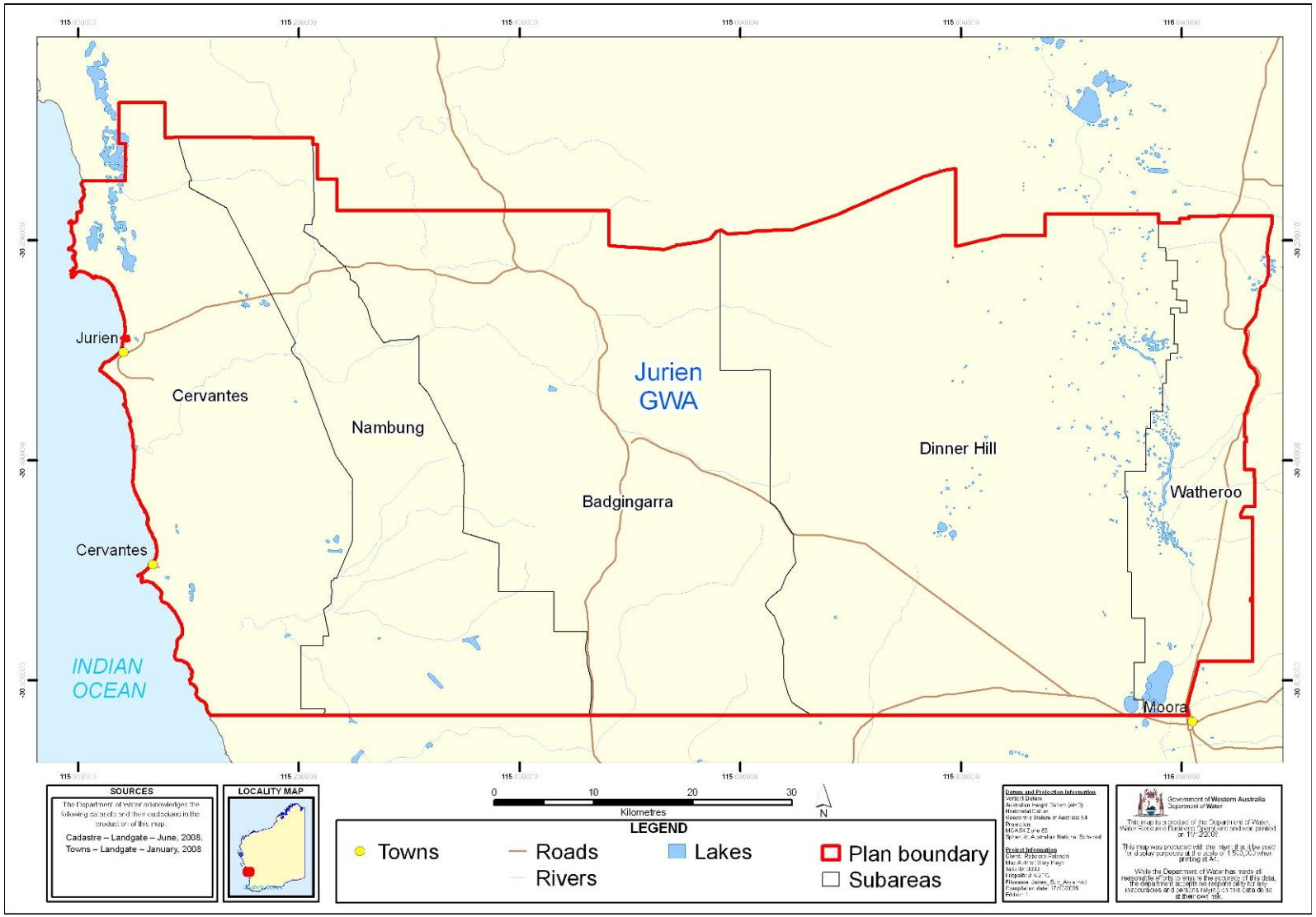

Figure 2 Jurien groundwater subareas

1.3 Historical allocation limits

The allocation limits for the Arrowsmith and Jurien groundwater areas were first set in the *Arrowsmith groundwater area management plan 1995* and *Jurien groundwater area management plan 1995* by the Water Authority. The methodology used in developing these limits is reproduced in Appendix A. The total water availability from each groundwater area at this time was 149.8 GL/yr (Arrowsmith) and 106.3 GL/yr (Jurien).

These limits were based on simple calculations from the geological drilling investigations carried out in the 1970s (Appendix A). The extent of investigations and monitoring undertaken reflected the demand for the water at the time, and the licensed entitlements in 1995 were small. This was evident in the tables presented as the aquifers with little or no information available were listed as 'unknown', while aquifers listed as 'limited' were described as having a limited supply due to a lack of aquifer thickness or the formation was largely unsaturated.

It is important to note that the subareas and the aquifers used in the 1995 plans were updated in 2002.

1.4 Interim allocation limits

The allocation limits set in the 1995 plans were reviewed as part of the development of *Managing the water resources in the Arrowsmith groundwater area – interim allocation strategy, 2002* and the *Managing the water resources in the Jurien groundwater area – interim allocation strategy, 2002* by the Water and Rivers Commission. The interim allocation limit calculations are reproduced in Appendix B, including a comparison with the original 1995 limits.

The interim allocation limit review updated the subareas (Figures 1 and 2) and aquifers of both the Arrowsmith and Jurien groundwater areas. The aquifers were updated in light of any new information from hydrogeological investigations carried out by the department, and through information collected from hydrogeological reports associated with licence applications. The bibliography lists the hydrogeological reports used.

Many of these documents are geological reports and drilling investigations which only cover the broad characteristics of parts of the Jurien and Arrowsmith groundwater areas. Not all aquifers or subareas are covered by these investigations. Further work was carried out after 2002, but there still remain many areas that are yet to be fully investigated.

1.5 Reviewing the allocation limits

Aim

Review the allocation limits for the Arrowsmith and Jurien groundwater areas for all subareas and aquifers, using a process that considers yield methodologies, water availability, monitoring data, licensed entitlement information, ecological, social and cultural information, and regional knowledge.

Purpose

The intent of this review is to make a reasonable volume of water available for consumptive use while considering the possibility of over-allocation and impacts on existing water users' rights. The allocation limits for each groundwater area and subarea were reviewed by aquifer (Section 2.5).

The review of the allocation limits was necessary in light of new information on current and future demand for water, and a review of the current information on groundwater-dependent ecosystems. The justification for any changes has been documented in Table 2 and 3.

The future hydrogeological investigations, additional ecological work and reports submitted to the department as part of licence applications will be used to inform the review of the allocation limits for the next plans scheduled for 2012.

2 Process

2.1 Decision-making process and methodology

The steps in the decision-making process for reviewing each of the allocation limits is described below.

1 Collect information and review past allocation limits and calculations (Appendices A and B).

2 Review current and future demand, including exempt use (Appendix C).

3 Develop options for updating the limits based on information and risk assignment (Section 2.2).

4 Apply option 4 and 5 to aquifers with no current monitoring or use (Section 2.3).

5 Meet with the project team to decide on the appropriate option for the remaining aquifers and subareas.

6 Document the options selected and justifications for each decision (Section 3.1 and 3.2).

7 Consider the department's position (Section 2.4) when finalising the allocation limits.

8 Finalise the allocation limits and publish in the allocation plans.

The process considers the limitations of the information in deciding on what the final allocation limit for each subarea and aquifer should be.

The monitoring of water levels is important in analysing the potential risk to the aquifer as it shows how the current abstractions and climate are affecting the water levels within the aquifer. The lack of monitoring is an added risk in some areas. The weight given to the information is determined by the level of risk assigned to the consequences of allowing more water to be allocated.

2.2 Information used

Information collected from the department's data bases and from a literature search for each aquifer and subarea was used to determine which option was suitable (Table 1) to choose, as understanding on the movement of groundwater is limited and there was no conceptual or mathematical hydrogeological model available.

The following documents were used to provide information on the hydrogeology and groundwater-dependent systems for each aquifer and subarea, where applicable:

- Water and Rivers Commission 2002, *Managing the water resources of the Arrowsmith groundwater area, WA – interim sub-regional allocation strategy,* Water and Rivers Commission, Government of Western Australia, Perth.
- Water and Rivers Commission 2002, *Managing the water resources of the Jurien groundwater area, WA – interim sub-regional allocation strategy*, Water and Rivers Commission, Government of Western Australia, Perth.
- Bekele EB, Salama RB, Commander DP, Otto CJ, Hick WP, Watson GD, Pollock DW and Lambert PA 2003, *Estimation of groundwater recharge to the Parmelia aquifer in the Northern Perth Basin 2001–2003*, CSIRO Land and Water, Technical Report 10/03.
- Welker Environmental Consultancy 2003, *Jurien region ecological water requirements study*, report prepared for the Water Corporation, Perth.
- Lindsay RP 2004, *The relationship between Hill River and groundwater, Jurien region*, Hydrogeology report no. 232, Department of Environment, Government of Western Australia, Perth.
- Rutherford J, Roy V and Johnson SL 2005, *The hydrogeology of groundwater dependent ecosystems in the Northern Perth Basin*, Department of Environment, Hydrogeological Record Series, HG11.
- Wetland Research and Management 2005, *Ecological water requirements of Hill River – intermediary assessment*, prepared for the Department of Environment, Government of Western Australia, Perth.
- Johnson SL and Commander DP 2006, *Mid West regional minerals study – groundwater resource appraisal,* Hydrogeological record series HG 17, Department of Water, Government of Western Australia, Perth.
- Irwin R 2007, *Hydrogeology of the Dongara borehole line*, Hydrogeological record series, HG 4, Department of Water, Government of Western Australia, Perth.
- Department of Water 2009, *Environmental considerations for groundwater management in the Northern Perth Basin*, Department of Water, Government of Western Australia, Perth.

The following data and tools were also used:

- Water resource licensing reports from November 2008. These reports provided data on current allocation limits, licensed entitlements, existing public water supply reserves and requested unprocessed allocations (Appendix E)
- Figures showing water level information (from the monitoring bores current to November 2008 from the water information network database)
- Maps of potential groundwater-dependent sites (see DoW 2009)
- Regional estimated use of licensed and exempt stock, domestic and garden bores in the plan area (Appendix C).

2.3 Options for reviewing the allocation limits

Table 1 shows the list of options developed to assist in determining the allocation limits for each aquifer and subarea. The options are presented with benefits and risks — to both the resource and to current and future applicants. In general the previous allocation limits set were precautionary and based on the level of hydrogeological knowledge. However climate change, water level changes in the aquifer, demand pressures, current abstraction, and the level of uncertainty in the location and requirements of social, cultural and ecologically groundwater-dependent systems needed to be reconsidered after six years.

Each option provides a scenario where a climate, environment or management factor can be applied to the existing allocation limits, which may increase or decrease the amount of water available for use (Section 2.3; Table 1). A level of risk is assigned to the water resource and use of the water resource for each option. The lower the level of information the higher the risk assigned, as over-allocation may occur. This is particularly difficult when the aquifer's ability to respond to increased abstraction, changes in throughflow, recharge or pressure is unknown.

Each of these options allows for water to be taken from fresh and saline parts of the aquifer (see detail in Appendix B). The location and depth of an aquifer will determine which part of the aquifer is being accessed, and this will be managed through the policies in the plan. Where allocation limits are set the draw is assumed to be across the whole subarea.

The policies in the new Jurien and Arrowsmith groundwater area allocation plans aim to minimise impact on existing users and the environment.

Table 1 Options for setting the allocation limits

N°	Option	Benefit	Risk	
			To the resource	To current and future applicants
1	Modify limits for climate factor [a]	• Accounts for a climate factor in recharge of an aquifer • Allows for small buffer in limits in areas reaching full allocation • Policies in the plan still apply	• Moderate • Does not account for GDE[1]/salt water interface in unconfined aquifers	• Low • Less water available, without additional work • Policies in the plan apply
2	Modify limits for climate factor and 30% for GDE[d]/salt water interface [b]	• Accounts for a climate factor in recharge of an aquifer • Accounts for climate uncertainty and allows for some maintenance of salt water interface and GDE • Policies in the plan still apply	• Moderate • GDE/salt water only accounted for – may not be protected in some areas	• Moderate • Less water available, without additional work • Policies in the plan will require additional work (monitoring and drilling) by applicants in areas of likely GDE[1]/salt water interface
3	Modify limits for climate factor and 70% for GDE/salt water interface [b]	• Accounts for a climate factor in recharge of an aquifer • Accounts for climate uncertainty and allows for maintenance of salt water interface and GDE • Lower limits allow for greater protection of the groundwater resources • Policies in the plan still apply	• Low	• Moderate • Less water available, without additional work by the applicant • Policies in the plan require additional work (monitoring and drilling) by applicants in areas of likely GDE/salt water interface
4	No modification. Any changes are for accounting purposes only [a]	• No changes to limits • Policies in the plan still apply	• Moderate • Unknown risks to resource and dependent systems	• Low • Limits show availability and can be applied for • Policies in the plan apply

N°	Option	Benefit	Risk	
			To the resource	To current and future applicants
5	Limits removed from the plan until a hydrogeological investigation is completed [c]	• Any application received wanting water from this particular aquifer will be required to undertake their own investigations to prove the resource is capable of supplying the requested entitlement, while still meeting the policies in the plan • Applicants could wait until the department's level of information increased before applying for a licence • Policies in the plan still apply	• Low • No abstraction without investigations, pump tests, hydrogeological report etc.	• High • Investigations would be required so this would restrict the kinds of activities that could invest the money in proving the resource is viable. • Increases time for implementing activity associated with the application • Policies in the plan apply

a. *Applies to all aquifers*

b. *Applies mainly to unconfined and semi-confined aquifers*

c. *Applies to confined aquifers only where investigations have not been undertaken*

d. *Groundwater-dependent ecosystem (includes groundwater-surface water connectivity). In meeting these requirements most social and cultural water requirements will be met in situ, except in areas where water is required to be abstracted to meet these requirements (e.g. Aboriginal community bore or spring).*

2.4 Departmental principles for allocating water

In completing the decision-making process the department applied several of its water resource management positions in process described in Section 2.1, taking into account all of the information presented before finalising the numbers (Section 3.3).

The positions are:

- We recognise existing water users' rights and has accounted for this when considering any changes to the allocation limits.
- We recognise that climate change must be a factor to be considered in protecting existing users' rights and the environment from over allocation.
- We consider the *in situ* social, cultural and ecological water requirements of an aquifer when determining the allocation limits.

It is important to note that the level of knowledge on groundwater-dependency for social, cultural and ecological sites was not adequate to determine environmental water provisions for each aquifer and subarea. As a result a low risk approach was adopted in setting the allocation limits until further work is completed for the next review in 2012. While climate information is built into the supporting information, the allocation limits are precautionary in areas where information is limited.

3 Allocation limit decisions

The allocation limit decision-making process is documented for each aquifer and subarea in sections 3.1–3.3. The tables include which option was chosen from Table 1 and the justification for the volume of water set as the limit. There are different levels of uncertainty in our knowledge of each aquifer, so in areas where the information is limited a precautionary approach is generally taken.

Options 1, 2 or 3 were not chosen for any of the water resources in reviewing the allocation limits. Each of these options was discussed in light of the information presented. Use of a climate factor and an environmental water factor was not considered appropriate for the Jurien and Arrowsmith groundwater areas because:

- rainfall figures used in the 2002 allocation limit tables were already conservative and the average annual rainfall (400–500 mm/yr) has not markedly changed.
- allowing for water for the environment was already accounted for in the 2002 allocation limits (30% of rainfall recharge in unconfined aquifers and 10% of rainfall recharge for confined aquifers).

As discussed in *Environmental considerations for groundwater management in the Northern Perth Basin* (DoW 2009) there is only limited on-ground information to verify the groundwater-dependency of ecosystems in this area. Therefore environmental factor used in the last review of the allocation limits was considered to be acceptable until further investigations have been completed.

It was noted that changes in intensity and duration of rainfall events will have more of an impact on rainfall recharge to groundwater aquifers than a small decrease in annual recharge will. This has been seen in some areas where cyclone events have temporarily increased the water levels within an aquifer. As the allocation limits are designed to manage a continuous water level we cannot yet capitalise on any random increase that results from these events.

The nature of the aquifer systems and the level of salinity in many aquifers were also discussed. Many aquifers within the Jurien and Arrowsmith groundwater areas have high salinity which is likely to restrict their use in the future (Table 2 and Table 4). The nature of many of the groundwater aquifers will also restrict access, with several aquifers too deep or discontinuous across their known extent.

The two most important water resource management considerations for most aquifers were:

- the management of the coastal area (salt water interface)
- the management of surface water features known to have groundwater connectivity.

These issues will be managed through the licensing policies in the plan.

3.1 Superficial, Surficial and fractured rock aquifers

Table 2 Justifications for the new Arrowsmith groundwater area allocation limits in the watertable aquifers

Subarea	Aquifer	Allocation limit kL/yr [a]	Option	Water quality [d]	Justification
Darling	Surficial	N/A (2 500 000)	-	Moderately–highly saline (close to lakes)	Limit is for accounting purposes only, as the limit is not necessary for water management as use is generally exempt stock watering. It is not possible to draw large volumes from this aquifer because it is localised, discontinuous, thin, and only sparsely saturated.
	Fractured Rock	N/A	-	Unknown	All applications in fractured rock must be assessed through the policies in the plan. Limits do not apply because the extent of each fracture (resource) is unknown.
Dongara	Superficial	8 000 000	4	Fresh–brackish. Fresh part of resource = 50% of allocation limit.	Existing allocation limits currently factor in 30% of rainfall recharge for dependent systems. It is currently unknown if this is sufficient to support identified potential groundwater-dependent ecosystems. Existing allocation limit only applies to the fresh water component of aquifer. Demand around the Irwin horticultural area is unlikely to increase. Public water supply needs requires review. Limits were not changed as there was not sufficient evidence to decrease the limits and draw is likely to be sporadic, which will be managed through the policies in the plan.

Subarea	Aquifer	Allocation limit kL/yr [a]	Option	Water quality [d]	Justification
Eneabba Plains	Superficial	14 600 000	4	Fresh–marginal. Fresh part of resource = 50% of allocation limit.	Existing allocation limits currently factor in 30% of rainfall recharge for dependent systems. It is currently unknown if this is sufficient to support identified potential groundwater-dependent ecosystems. Existing allocation limit only applies to the fresh water component of aquifer. Demand around the Irwin horticultural area is unlikely to increase. Future mining expansion may occur, but is unlikely to increase groundwater abstraction. Public water supply needs requires review Limits were not changed as there was not sufficient evidence to decrease the limits and draw is likely to be concentrated in one area, which will be managed through the policies in the plan.
Twin Hills	Surficial	N/A (600 000)	-	Fresh–marginal	Limit is for accounting purposes only, as the limit is not necessary for water management as use is generally exempt stock watering. It is not possible to draw large volumes from this aquifer because it is localised, discontinuous, thin, and only sparsely saturated.

Table 3 Justifications for the new Jurien groundwater area allocation limits in the watertable aquifers

Subarea	Aquifer	Allocation limit kL/yr [a]	Option	Water quality [d]	Justification
Cervantes	Superficial	30 000 000	4	Fresh–marginal. Fresh part of resource = 50% of allocation limit.	Existing allocation limits currently factor in 30% of rainfall recharge for dependent systems. It is currently unknown if this is sufficient to support identified potential groundwater-dependent ecosystems. Existing allocation limits only apply to fresh water component of aquifer. Demand around the town sites of Jurien and Cervantes is likely to increase. This will mean an increase in demand for public water supply. Public water supply needs requires review This area will require closer management in the areas not covered by national park or reserves to make sure that any groundwater-dependent ecosystems are protected (caves, wetlands etc).

Subarea	Aquifer	Allocation limit kL/yr [a]	Option	Water quality [d]	Justification
Dinner Hill	Surficial	N/A (1 000 000)	4	Fresh–brackish	Limit is for accounting purposes only, as the limit is not necessary for water management as use is generally exempt stock watering. It is not possible to draw large volumes from this aquifer because it is localised, discontinuous, thin, and only sparsely saturated. Any new use of this resource (other than exempt use) will be required to provide bore construction details before a licence to take water can be issued to ensure it has not been drilled into the Leederville–Parmelia aquifer.
Nambung	Superficial	4 000 000	4	Fresh–marginal	Current use is localised and for mining. Any large scale future use will likely be for mining or potentially irrigated pasture/ horticulture which will require applicants to undertake investigations as per the policies in the plan.
Watheroo	Surficial	N/A (300 000)	-	Brackish–moderately saline	Limit is for accounting purposes only, as the limit is not necessary for water management as use is generally exempt stock watering. It is not possible to draw large volumes from this aquifer because it is localised, discontinuous, thin, and only sparsely saturated.
	Fractured Rock	N/A (600 000)	-	Unknown	Limit is for accounting purposes only, as the limit is not necessary for water management as use is generally exempt stock watering. It is not possible to draw large volumes from this aquifer because it is localised, discontinuous, thin, and only sparsely saturated.

Notes for Table 2 and 3

a. *Where an allocation limit is N/A there is only a small amount of water set in the water accounting system to cover exempt use and any small allocations if water can be found and correctly identified as being from that aquifer. Most of the aquifers with low allocation limits (<500 000 kL/yr) are limited in their availability by location of the aquifer and extent of the saturation of the aquifer. These limits are for accounting purposes only. Any licence application wanting water from these aquifers will be required to undertake hydrogeological investigations before a licence can be issued.*

b. *The Surficial aquifer may be present in the Allanooka, Eneabba Plains, Tathra, Mingenew and Morrison subareas but has no allocation limit. Limit is not necessary for water management as use is generally exempt stock watering. It is not possible to draw large volumes from this aquifer because it is localised, discontinuous, thin, and only sparsely saturated.*

c. *The Surficial aquifer may be present in the Badgingarra subarea but has no allocation limit. Limit is not necessary for water management as use is generally exempt stock watering. It is not possible to draw large volumes from this aquifer because it is localised, discontinuous, thin, and only sparsely saturated.*

d. *500 mg/L TDS Fresh, 500–1000 mg/L TDS Marginal, 1000–2000 mg/L TDS Brackish, 2000–5000 mg/L TDS Moderately saline, 5000–10 000 mg/L TDS Saline, 10 000–35 000 mg/L TDS Highly saline, > 35 000 mg/L TDS Hyper-saline*

3.2 Sedimentary aquifers

Table 4 Justifications for the new Arrowsmith groundwater area allocation limits in the sedimentary aquifers

Subarea	Aquifer	Allocation limit kL/yr [a]	Option	Water quality [b]	Justification
Allanooka	Yarragadee	28 800 000	4	Fresh	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. Monitoring shows increase in water levels in recharge area. Current use is low.
Darling	Cattamarra	N/A (400 000)	4	Brackish	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. The aquifer is not currently used or monitored. There is limited hydrogeological information. Investigations are required for any application.
	Eneabba	N/A (400 000)	4	Highly saline	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. The aquifer is not currently used or monitored. There is limited hydrogeological information. Investigations required for any application.
	Lesueur	1 400 000	4	Fresh–brackish	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. The aquifer is not currently used or monitored. There is limited hydrogeological information. Investigations required for any application.
	Parmelia	N/A (100 000)	4	Fresh–marginal	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. The aquifer is not currently used or monitored. There is limited hydrogeological information. Investigations required for any application.
	Yarragadee	N/A (200 000)	4	Highly saline	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. The aquifer is not currently used and there is limited monitoring undertaken. There is limited hydrogeological information. Investigations are required for any application.

Subarea	Aquifer	Allocation limit kL/yr [a]	Option	Water quality [b]	Justification
Dongara	Cattamarra	N/A (200 000)	4	Brackish	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. Very small amount of use with no monitoring. There is limited hydrogeological information. Investigations required for any application.
	Yarragadee	4 500 000	4	Fresh part of resource	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. Monitoring is showing that water levels are currently stable.
Eneabba Plains	Cattamarra	N/A (100 000)	4	Brackish	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. The aquifer is not currently used. There is limited hydrogeological information. The limited amount of monitoring shows stable water levels. Investigations are required for any application.
	Eneabba	2 000 000	4	Fresh–brackish	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. Currently only used for mining purposes. There is limited hydrogeological information. The limited amount of monitoring shows stable water levels. Any application will require hydrogeological investigations.
	Lesueur	1 800 000	4	Fresh–brackish	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. This aquifer is not currently monitored and as such it is unknown if there are impacts from abstraction. Any application will require hydrogeological investigations.
	Yarragadee	22 500 000	4	Fresh part of resource	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. Monitoring is showing that water levels are stable.
Mingenew	Otorowiri	N/A (100 000)	4	Unknown	Limit set is for accounting purposes only. The aquifer is not currently used or monitored. No hydrogeological investigations have been undertaken. Aquifer is an aquitard and generally unsaturated. Any applicant wanting water from this resource will be required to undertake detailed hydrogeological investigations.
	Parmelia	8 200 000	4	Fresh part of resource	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. Limited monitoring shows increase in water levels in recharge area.

Subarea	Aquifer	Allocation limit kL/yr [a]	Option	Water quality [b]	Justification
Morrison	Otorowiri	N/A (100 000)	4	Unknown	Limit set is for accounting purposes only. The aquifer is not currently used or monitored. No hydrogeological investigations have been undertaken. Aquifer is an aquitard and generally unsaturated. Any applicant wanting water from this resource will be required to undertake detailed hydrogeological investigations.
	Parmelia	4 000 000	4	Fresh part of resource	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. The aquifer is not currently used or monitored. There is limited hydrogeological information. Investigations are required for any application. Monitoring shows increase in water levels in recharge area (outside the subarea).
	Yarragadee	1 000 000	4	Fresh–brackish	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. The aquifer is not currently used or monitored. There is limited hydrogeological information. Investigations are required for any application.
Tathra	Cattamarra	N/A (50 000)	4	Saline	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. The aquifer is not currently used or monitored. There is limited hydrogeological information. Investigations required for any application.
	Eneabba	N/A (100 000)	4	Fresh–brackish	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. The aquifer is not currently used or monitored. There is limited hydrogeological information. Investigations required for any application.
	Lesueur	N/A (100 000)	4	Fresh–brackish	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. The aquifer is not currently used or monitored. There is limited hydrogeological information. Investigations required for any application.
	Parmelia	33 400 000	4	Fresh	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. Limited monitoring shows increase in water levels. Reason is unknown.

Subarea	Aquifer	Allocation limit kL/yr [a]	Option	Water quality [b]	Justification
	Yarragadee	700 000	4	Fresh–brackish	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. The aquifer is not currently used and there is limited monitoring undertaken. There is limited hydrogeological information. Investigations are required for any application.
Twin Hills	Cattamarra	N/A (500 000)	4	Brackish	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. Very small amount of use with no monitoring. There is limited hydrogeological information. Investigations required for any application.
	Eneabba	N/A (400 000)	4	Fresh–brackish	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. The aquifer is not currently used or monitored. There is limited hydrogeological information. Investigations required for any application.
	Lesueur	N/A (200 000)	4	Fresh–brackish	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. The aquifer is not currently used or monitored. There is limited hydrogeological information. Investigations required for any application.
	Otorowiri	N/A (100 000)	4	Unknown	Limit set is for accounting purposes only. The aquifer is not currently used or monitored. No hydrogeological investigations have been undertaken. aquifer is an aquitard and generally unsaturated. Any applicant wanting water from this resource will be required to undertake detailed hydrogeological investigations.
	Parmelia	3 400 000	4	Fresh part of resource	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. The aquifer is not currently used or monitored. Monitoring outside of this subarea (east) has shown an increase in water levels. The extent of formation is unknown. Any applicant wanting water from this resource will be required to undertake detailed hydrogeological investigations.
	Yarragadee	48 800 000	4	Fresh part of resource	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. Limited monitoring shows increase in water levels in recharge area.

Table 5 Justifications for the new Jurien groundwater area allocation limits in the sedimentary aquifers

Subarea	Aquifer	Allocation limit kL/yr [a]	Option	Water quality [b]	Justification
Badgingarra	Cattamarra	N/A (400 000)	4	Brackish–saline	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. Limited monitoring shows water levels are stable. The extent of formation is unknown. Any applicant wanting water from this resource will be required to undertake detailed hydrogeological investigations.
	Leederville–Parmelia	N/A (300 000)	4	Fresh–brackish	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. The aquifer is not currently used or monitored. There is limited hydrogeological information. The extent of formation is unknown. Any applicant wanting water from this resource will be required to undertake detailed hydrogeological investigations.
	Otorowiri	N/A (100 000)	4	Unknown	Limit set is for accounting purposes only. The aquifer is not currently used or monitored. No investigations undertaken. aquifer is an aquitard and generally unsaturated. Any applicant wanting water from this resource will be required to undertake detailed hydrogeological investigations.
	Yarragadee	27 500 000	4	Fresh part of resource	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. Limited monitoring shows increase in water levels in recharge area.
Cervantes	Cattamarra	N/A (100 000)	4	Brackish–saline	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. The aquifer is not currently used or monitored. There is limited hydrogeological information. Investigations required for any application.
	Eneabba	N/A (600 000)	4	Fresh–brackish	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. The aquifer is not currently used or monitored. There is limited hydrogeological information. Investigations required for any application.

Subarea	Aquifer	Allocation limit kL/yr [a]	Option	Water quality [b]	Justification
	Lesueur	3 000 000	4	Fresh–marginal	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. The aquifer is not currently used. Monitoring has shown some localised water level declines – but there is no use from this aquifer in this subarea. Any application will require hydrogeological investigations.
Dinner Hill	Leederville–Parmelia	12 600 000	4	Fresh part of resource	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. aquifer is highly requested. A process to re-allocate remaining available will be undertaken. Monitoring is showing an increase in water levels across most of the area, with some bores close to abstraction points stable. Exempt use requires review.
	Mirrabooka	N/A (500 000)	4	Fresh–brackish	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. The aquifer is not currently used or monitored. No investigations undertaken. Any applicant wanting water from this resource will be required to undertake detailed hydrogeological investigations.
	Otorowiri	N/A (100 000)	4	Unknown	Limit set is for accounting purposes only. The aquifer is not currently used or monitored. No investigations undertaken. aquifer is an aquitard and generally unsaturated. Any applicant wanting water from this resource will be required to undertake detailed hydrogeological investigations.
Nambung	Cattamarra	1 600 000	4	Brackish–saline	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. The aquifer is not currently used and there is limited monitoring undertaken. There is limited hydrogeological information. Investigations are required for any application.
	Eneabba	N/A (300 000)	4	Fresh–brackish	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. The aquifer is not currently used or monitored. There is limited hydrogeological information. Investigations required for any application.

Subarea	Aquifer	Allocation limit kL/yr [a]	Option	Water quality [b]	Justification
	Lesueur	2 700 000	4	Fresh–marginal	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. The aquifer is not currently used or monitored. There is limited hydrogeological information. Investigations required for any application.
	Yarragadee	8 800 000	4	Fresh part of resource	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. Limited monitoring is showing stable in water levels.
Watheroo	Leederville–Parmelia	N/A (100 000)	4	Brackish–moderately saline	Interim allocation limits from 2002 (Appendix B) were confirmed as appropriate. The aquifer is not currently used or monitored. There is limited hydrogeological information. Investigations required for any application.

Notes for Table 4 and 5:

a. *Where an allocation limit is N/A there is only a small amount of water set in the water accounting system to cover exempt use and any small allocations if water can be found and correctly identified as being from that aquifer. Most of the aquifers with low allocation limits (<500 000 kL/yr) are limited in their availability by location of the aquifer and extent of the saturation of the aquifer. These limits are for accounting purposes only. Any licence application wanting water from these aquifers will be required to undertake hydrogeological investigations before a licence can be issued.*

b. *< 500 mg/L TDS Fresh, 500–1000 mg/L TDS Marginal, 1000–2000 mg/L TDS Brackish, 2000–5000 mg/L TDS Moderately saline, 5000–10 000 mg/L TDS Saline, 10 000–35 000 mg/L TDS Highly saline, > 35 000 mg/L TDS Hyper-saline.*

3.3 Final allocation limits

The final allocation limits are presented in Tables 6 and 7. The allocation limits will be presented in each of the allocation plans.

The allocation limits column represents the total volume of water that is for consumptive use. The department's water resource licensing database (WRL) will use the numbers listed in the DWAID column for the licensing of water entitlements. This system allows for the exempt use to be accounted for in the total amount allowable for abstracted from any given water resource without compromising the use of the water.

Table 6 Allocation limits for the Arrowsmith groundwater areas to be used in water accounting systems (DWAID) (kL/yr)

Subarea	Aquifer	Allocation limit	Estimated exempt use	DWAID allocation limit*
Allanooka	Yarragadee	28 800 000	300 000	28 500 000
Darling	Cattamarra	400 000	0	400 000
	Eneabba	400 000	0	400 000
	Lesueur	1 400 000	0	1 400 000
	Parmelia	100 000	0	100 000
	Surficial	2 500 000	590 000	1 910 000
	Yarragadee	200 000	0	200 000
Dongara	Cattamarra	200 000	0	200 000
	Superficial	8 000 000	370 000	7 630 000
	Yarragadee	4 500 000	750 000	3 750 000
Eneabba Plains	Cattamarra	100 000	0	100 000
	Eneabba	2 000 000	0	2 000 000
	Lesueur	1 800 000	0	1 800 000
	Superficial	14 600 000	130 000	14 470 000
	Surficial	0	0	0
	Yarragadee	22 500 000	260 000	22 240 000
Mingenew	Otorowiri	100 000	0	100 000
	Parmelia	8 200 000	40 000	8 160 000
Morrison	Otorowiri	100 000	0	100 000
	Parmelia	4 000 000	60 000	3 940 000
	Yarragadee	1 000 000	0	1 000 000
Tathra	Cattamarra	50 000	0	50 000
	Eneabba	100 000	0	100 000
	Lesueur	100 000	0	100 000

Subarea	Aquifer	Allocation limit	Estimated exempt use	DWAID allocation limit*
	Parmelia	33 400 000	810 000	32 590 000
	Surficial	0	0	0
	Yarragadee	700 000	0	700 000
Twin Hills	Cattamarra	500 000	0	500 000
	Eneabba	400 000	0	400 000
	Lesueur	200 000	0	200 000
	Otorowiri	100 000	0	100 000
	Parmelia	3 400 000	0	3 400 000
	Yarragadee	48 800 000	970 000	47 830 000
	Surficial	600 000	110 000	490 000
TOTAL		**189 250 000**	**4 390 000**	**184 860 000**

**Divertible water allocation inventory database (DWAID) allocation limits = allocation limit – estimated exempt use.*

Note: Most of the aquifers with low allocation limits (< 500 000 kL/yr) are limited in their availability by location of the aquifer and extent of the saturation of the aquifer. These numbers are for accounting purposes only. Any application wanting water from these aquifers will be required to undertake hydrogeological investigations before a licence can be issued.

Table 7 Allocation limits for the Jurien groundwater areas to be used in water accounting systems (DWAID) (kL/yr)

Subarea	Aquifer	Allocation limit	Estimated exempt use	DWAID allocation limit*
Badgingarra	Cattamarra	400 000	0	400 000
	Leederville–Parmelia	300 000	0	300 000
	Otorowiri	100 000	0	100 000
	Yarragadee	27 500 000	940 000	26 560 000
Cervantes	Cattamarra	100 000	0	100 000
	Eneabba	600 000	0	600 000
	Lesueur	3 000 000	550 000	2 450 000
	Superficial	30 000 000	280 000	29 720 000
Dinner Hill	Leederville–Parmelia	12 600 000	0	12 600 000
	Mirrabooka	500 000	0	500 000
	Otorowiri	100 000	0	100 000
	Surficial	1 000 000	530 000	470 000
Nambung	Cattamarra	1 600 000	0	1 600 000
	Eneabba	300 000	0	300 000
	Lesueur	2 700 000	0	2 700 000
	Superficial	4 000 000	370 000	3 630 000
	Yarragadee	8 800 000	0	8 800 000

Subarea	Aquifer	Allocation limit	Estimated exempt use	DWAID allocation limit*
Watheroo	Leederville–Parmelia	100 000	0	100 000
	Surficial	300 000	90 000	210 000
	Fractured Rock	600 000	270 000	330 000
TOTAL		**94 600 000**	**3 030 000**	**91 570 000**

**Divertible water allocation inventory database (DWAID) allocation limits = allocation limit – estimated exempt use.*

Note: Most of the aquifers with low allocation limits (< 500 000 kL/yr) are limited in their availability by location of the aquifer and extent of the saturation of the aquifer. These numbers are for accounting purposes only. Any application wanting water from these aquifers will be required to undertake hydrogeological investigations before a licence can be issued.

Appendices

Appendix A — Historical allocation limits (1995)

Table A1 contains the numbers used in calculating the amount of water available for consumptive use in the Arrowsmith and Jurien groundwater areas in 1995. The following notes explain the calculations and justifications for some of the decisions made. All information has been extracted and reproduced from the *Jurien groundwater area management plan 1995* and *Arrowsmith groundwater area management plan 1995.*

Notes from the original 1995 plans:

- *Total supply* in GL/yr is calculated from aquifer area and rainfall recharge estimates for each individual aquifer section. *Sustainable supply* is the total supply minus that component of the resource set aside for maintaining environmentally sensitive areas (e.g. wetlands). The sustainable supply is the total resource available for allocation for public and private use.
- The Dandaragan Sandstone, Leederville Formation and Parmelia Formation are considered together as one hydraulic unit (aquifer system).
- The Cattamarra Coal Measures and Eneabba Formation are combined.
- Where an aquifer limit is listed as not evaluated it refers to the aquifer characteristics such as the Cattamarra and Eneabba formation where the water quality is generally brackish and therefore has not be considered as a resource.
- The Superficial formations in the Badgingarra, Eneabba Plain, Twin Hills, Allanooka and Dandaragan subareas have a limited supply due to a lack of aquifer thickness or the formation is largely unsaturated.
- The Yarragadee Formation in the Dinner Hill subarea was not evaluated because it exists at great depth.
- Groundwater availability in the Surficial aquifer (Darling and Watheroo subareas) is generally small due to a lack of aquifer thickness, some low yielding groundwater supplies do exist.
- Total sustainable supply for the area is the total amount of groundwater available for allocation — it includes all current abstraction for public and private water supply and future public use as well as the unallocated resources.
- A value of 25% rainfall recharge was used (Arrowsmith)

Recharge area is about ⅓ of northern flow system	476	km^2
Plus recharge area of central flow system	1500	km^2
Plus recharge are of southern flow system	340	km^2
Total recharge area	**2316**	**km^2**
Recharge area south of Irwin River	1000	km^2
Plus recharge area of north of Irwin River	100	km^2
Total recharge area	**1100**	**km^2**

Table A1 Subarea groundwater calculations for Arrowsmith groundwater areas 1995

Subarea	Aquifer	Area km^2	Rainfall mm/yr	Recharge rate %	Total supply GL/yr	Environment GL/yr	Sustainable supply GL/yr
Dongara	Superficial	250	600	0.18	27.0	19.0	8.0
	Parmelia	Absent					0
	Yarragadee	Absent					0
	Cattamarra and Eneabba	Absent					0
	Lesueur	Absent					0
Eneabba Plain	Superficial	?					Limited
	Parmelia	Absent					0
	Yarragadee	1100	550	0.05	30.0	7.5	22.7
	Cattamarra and Eneabba	155	600	0.02	2.0	0	2.0
	Lesueur	45	600	0.09	2.4	0.6	1.8
Twin Hills	Superficial	?					Limited
	Parmelia	Absent					0
	Yarragadee	1600	550	0.05	44.0	11.0	33.0
	Cattamarra and Eneabba	155	600	0.02	2.0	0.5	1.5
	Lesueur	5	600	0.09	0.3	0.1	0.2
Allanooka	Superficial	?					Limited
	Parmelia	Absent					0
	Yarragadee	396	388	0.25	38.4	9.6	28.8
	Cattamarra and Eneabba	Absent					0
	Lesueur	Absent					0

Subarea	Aquifer	Area km^2	Rainfall mm/yr	Recharge rate %	Total supply GL/yr	Environment GL/yr	Sustainable supply GL/yr
Dandaragan	Superficial	?					Limited
	Parmelia	2316	450	0.005	52.0	0.0	52.0
	Yarragadee	?			Not assessed		Unknown
	Cattamarra and Eneabba	Absent					0
	Lesueur	Absent					0
Darling	Superficial	?					Limited
	Parmelia	Absent					0
	Yarragadee	Absent					0
	Cattamarra and Eneabba	Absent					0
	Lesueur	Absent					0

Table A2 Subarea groundwater calculations for Jurien groundwater areas 1995

Subarea	Aquifer	Area km^2	Rainfall mm/yr	Recharge rate %	Total supply GL/yr	Environment GL/yr	Sustainable supply GL/yr
Cervantes	Superficial	350	600	0.18	37.8	24.3	13.5
	Dandaragan Sandstone, Leederville and Parmelia	Absent					0
	Yarragadee	Absent					0
	Cattamarra and Eneabba	Absent					0
	Lesueur	75	600	0.09	4.0	1.0	3.0
Nambung	Superficial	500	600	0.18	54.0	19	35.0
	Dandaragan Sandstone, Leederville and Parmelia	Absent					0

Subarea	Aquifer	Area km^2	Rainfall mm/yr	Recharge rate %	Total supply GL/yr	Environment GL/yr	Sustainable supply GL/yr
	Yarragadee	175	600	0.09	9.5	2.4	7.1
	Cattamarra and Eneabba	Unknown					Unknown
	Lesueur	175	600	0.09	9.5	2.4	7.1
Badgingarra	Superficial	Unknown					Limited
	Dandaragan Sandstone, Leederville and Parmelia	Absent					0
	Yarragadee	800	600	0.05	24.0	6.0	18.0
	Cattamarra and Eneabba	Unknown					Unknown
	Lesueur	40	600	0.09	2.2	0.5	1.7
Dinner Hill	Superficial	Unknown					Limited
	Dandaragan Sandstone, Leederville and Parmelia	925	450	0.05	20.8	0	20.8
	Yarragadee	Unknown					Unknown
	Cattamarra and Eneabba	Absent					0
	Lesueur	Absent					0
Watheroo	Surficial	Unknown					Limited
	Dandaragan Sandstone, Leederville and Parmelia	Absent					0
	Yarragadee	Absent					0
	Cattamarra and Eneabba	Absent					0
	Lesueur	Absent					0

Appendix B – Interim allocation limits (2002)

Table B1 2002 Allocation limit methodology for Arrowsmith groundwater areas (GL/yr)

Subarea	Aquifer	Area km^2	Rainfall mm/yr	Recharge rate	Total gross recharge	Preliminary EWP based on rainfall recharge over subarea [a]	Sustainable yield	Previous allocation limit (1995)	New allocation limit	Net change
Dongara	Superficial	167.50 [b]	500	0.06	5.03	1.51	3.52	8.0	8.4 [c]	
	Yarragadee	2.82		0.05	0.07	0.01	0.1	4.5	4.5 [d]	
	Cattamarra	44.69		0.01	0.22	0.02	0.2	0	0.2	+0.2
Eneabba Plains	Superficial	472.50 [b]	550	0.08	20.79	6.24	14.55	0	14.6 [e]	+14.6
	Yarragadee	797.13		0.05	21.92	2.19	19.7	22.5	22.5 [f]	
	Cattamarra	90.93		0.01	0.50	0.05	0.5	(~1.0)[g]	0.2	-0.8
	Eneabba	29.19		0.03	0.48	0.05	0.4	(~1.0)[g]	2.0 [h]	+1.0
	Lesueur	62.33		0.03	1.03	0.10	0.9	1.8	1.8 [i]	-0.9
Twin Hills	Otorowiri	Unknown							0.5 [j]	+0.5
	Parmelia	136.96		0.05	3.77	0.38	3.4	0	3.4	+3.4
	Yarragadee	1971.58		0.05	54.22	5.42	48.8	33.0	48.8	+15.8
	Cattamarra	98.63		0.01	0.54	0.05	0.5	1.5	0.5	-1.0
	Eneabba	29.82		0.03	0.49	0.05	0.4	0.5	0.4	-0.1
	Lesueur	9.59		0.03	0.16	0.02	0.1	0.2	0.2 [i]	
Allanooka	Yarragadee	544.39		0.10	24.50	2.46	22.0	28.8	28.8 [k]	
Mingenew	Surficial	0	500					Limited	0 (mostly unsaturated)	
	Otorowiri	Unknown							0.1 [j]	
	Parmelia	365.16		0.05	9.13	0.91	8.2		8.2	

Subarea	Aquifer	Area km^2	Rainfall mm/yr	Recharge rate	Total gross recharge	Preliminary EWP based on rainfall recharge over subarea [(a)]	Sustainable yield	Previous allocation limit (1995)	New allocation limit	Net change
	Fractured Rock	Unknown							Unknown	
Tathra	Surficial	0	500					Limited	0 (mostly unsaturated)	
	Parmelia	1491.80		0.05	37.30	3.70	33.4		33.4	
	Yarragadee	29.26		0.05	0.73	0.07	0.7	0 [(l)]	0.7 (brackish)	+0.7
	Cattamarra	6.00		0.01	0.03	0.0	0.03	0	0.1 (brackish)	+0.1
	Eneabba	5.68		0.03	0.08	0.01	0.1	0	0.1 (brackish)	+0.1
	Lesueur	10.68		0.03	0.16	0.02	0.1	0	0.1 (brackish)	+0.1
	Fractured rock	Unknown							Unknown	
Morrison	Surficial	0	500					Limited	0 (mostly unsaturated)	
	Otorowiri	Unknown							0.1 [(j)]	
	Parmelia	513.73							4.0 [(m)]	
	Yarragadee	11.51 29.26		0.05 0.05	0.29 0.73	0.03 0.07	0.3 0.7	0[(g)]	0.3 (fresh) 0.7 (brackish)	+0.7
	Cattamarra	12.49		0.01	0.06	0.01	0.1	0	0.1 (brackish)	+0.1
	Fractured rock	Unknown							Unknown	
Darling	Surficial	1227.40	450	0.065	35.90	10.77		Limited	2.5 [(n)]	
	Parmelia	3.51		0.05	0.08	0.01	0.1	0	0.1	+0.1
	Yarragadee	9.66		0.05	0.22	0.02	0.2	0	0.2 (brackish-saline)	+0.2
	Cattamarra	111.73		0.01	0.05	0.01	0.4	0	0.4 (saline)	+0.4

Subarea	Aquifer	Area km^2	Rainfall mm/yr	Recharge rate	Total gross recharge	Preliminary EWP based on rainfall recharge over subarea [(a)]	Sustainable yield	Previous allocation limit (1995)	New allocation limit	Net change
	Eneabba	30.70		0.03	0.41	0.04	0.4	0	0.4 (saline)	+0.4
	Lesueur	112.11		0.03	1.51	0.15	1.4	0	1.4 (brackish-saline)	+1.4
	Fractured rock	Unknown								

Table B2 2002 Allocation limit methodology for Jurien groundwater areas (GL/yr)

Subarea	Aquifer	Area km^2	Rainfall mm/yr	Recharge rate	Total gross recharge	Preliminary EWP based on rainfall recharge over subarea [(a)]	Sustainable yield	Previous allocation limit (1995)	New allocation limit	Net Change
Cervantes	Superficial	650.00[(b)]	600	0.11	42.90	12.87	30.0	13.5	30.0[(c)]	+16.5
	Cattamarra	11.20		0.01	0.07	0.01	0.1	0	0.1	+0.1
	Eneabba	36.75		0.03	0.66	0.07	0.6	0	0.6	+0.6
	Lesueur	71.95		0.03	1.30	0.13	1.2	3.0	3.0[(d)]	
Nambung	Superficial	95.00[(b)]	600	0.11	6.27	1.88	4.4	35.1	4.4[(c)]	-30.7
	Yarragadee	324.83		0.05 0.025	9.74	0.97	8.8	7.1	8.8	+1.7
	Cattamarra	286.45		0.01	1.72	0.17	1.6	0[(e)]	1.6	+1.6
	Eneabba	21.45		0.03	0.37	0.04	0.3	0[(e)]	0.3	+0.3
	Lesueur	98.40		0.05	2.95	0.30	2.7	7.1	2.7	-4.4
Badgingarra	Mirrabooka	Unknown							Unknown	
	Otorowiri	Unknown						0	0.7[(f)]	+4.7

Subarea	Aquifer	Area km^2	Rainfall mm/yr	Recharge rate	Total gross recharge	Preliminary EWP based on rainfall recharge over subarea [(a)]	Sustainable yield	Previous allocation limit (1995)	New allocation limit	Net Change
	Leederville–Parmelia	10.05 42.52		0.05 0.001	0.33	0.03	0.3	0	0.3	+0.3
	Yarragadee	1004.87		0.05	30.5	3.05	27.5	18.0	27.5	+9.5
	Cattamarra	77.73		0.01	0.47	0.05	0.4	0[(e)]	0.4	+0.4
	Lesueur	0[(g)]					0	1.7	0[(g)]	-1.7
Dinner Hill	Surficial	1100	500	0.065	35.75	10.73		Limited	3.2[(h)]	+3.2
	Mirrabooka	Unknown						-	0.5[(f)]	+0.5
	Otorowiri	Unknown		0.065	0.49	0.15	0.3	-	0.3[(f)]	+0.3
	Leederville–Parmelia	1583						20.8	12.6[(i)]	-8.2
	Yarragadee	Unknown						0[(f)]	Unknown	
	Fractured rock	115.14						-	Unknown	
Watheroo	Surficial							Limited	0.9[(j)]	+0.9
	Poison Hill	Unknown						0	Unknown	
	Leederville–Parmelia	62.10		0.001	0.03	0	0.03	0	0.1[(saline)]	+0.1
	Fractured rock	4275						-	Unknown	

Notes for Table B1 and B2:

a. *30% for unconfined Superficial and Surficial aquifers, 10% for confined aquifers.*

b. *Area of fresh groundwater (less than 1500 mg/L TDS).*

c. *Allocation limit represents 3.5 GL/yr of fresh water (<1500 mg/L TDS) and 4.5 GL/yr of brackish water (>1500 mg/L TDS).*

d. *New allocation limit represents the fresh water (<1500 mg/L TDS) component of the aquifer.*

e. *Yarragadee and Superficial aquifers are managed together.*

f. *Unchanged allocation limit. More detailed investigations justify keeping the same allocation limit.*

g. *Previous allocation limit was 2.0 GL/yr for both the Cattamarra and Eneabba aquifers.*

h. *More detailed investigations justify higher allocation limit.*

i. *Lesueur and Superficial aquifers are managed together.*

j. *Nominal allocation has been set because the extent of the aquifer has not been defined yet.*

k. *Local recharge component equals to 22.0 GL/yr and a conservative throughflow component of 6.8 GL/yr from the adjacent Casuarinas subarea has been considered. However, this needs to be confirmed through investigations.*

l. *Allocation limit not estimated.*

m. *Calculation based on a percentage of rainfall recharge over the whole aquifer system and allocation limit redistribution on a subarea basis.*

n. *Nominal allocation has been set because the extent of the aquifer has not been defined yet. The aquifer is comprised of the lateritic profile.*

Allocation limits for the Leederville—Parmelia aquifer in the Northern Perth Basin based on subarea size

The combined Leederville–Parmelia aquifer is mostly confined by thick shales of the Coolyena Group (e.g. Osborne Formation) in the eastern portion of the Jurien and Arrowsmith groundwater areas. Aquifer recharge occurs mainly in areas where the Coolyena Group is thin or absent. Consequently, the department has adopted a calculation methodology to set allocation limit based on a percentage of rainfall recharge over the whole aquifer system and redistributed on a subarea basis. This principle allows for more equitable distribution of the available resource.

The following figures have been used to calculate the allocation limit for each subarea:

- Total area of Leederville-Parmelia aquifer: 4570 km^2 (from groundwater divide to north of Perth region)
- Total recharge of the system: 40.5 GL/yr
- Interim EWP set at 10% of recharge: 4.0 G/L yr
- Total sustainable yield: 36.5 GL/yr
- Allocation/area: 36.5 GL/year/4570 km^2= 0.008 GL/yr/km^2 or 8000 kL/yr/km^2

Table B3 2002 Allocation limits calculations for Leederville–Parmelia aquifer

Subarea (groundwater area)	Area km^2	Allocation limit GL/yr	Remarks
Morrison (Arrowsmith)	500	4.0	Most area covered by uncleared Crown land and national park
Dinner Hill (Jurien)	1580	12.6	More water is available for allocation using this method than by calculation using local rainfall recharge (as per Table B1)
Total	**2080**	**16.6**	

Appendix C – Calculating exempt stock and domestic use

New allocation plans are being developed for the Arrowsmith and Jurien groundwater areas. Information is required relating to stock and domestic unlicensed (exempt) water use. The estimates for exempt use are part of updating the allocation limits and DWAID, to ensure that this use is recognised and accounted for in decision-making for the allocation plan.

Considerations for methodology

The groundwater areas are administrative boundaries based on the hydrogeology of the water resources

The groundwater areas do not always correlate with other administrative boundaries such as shires, which restricts methods of data collection. Similarly, the aquifers, which are accessed by exempt use, may not always correlate with groundwater subarea boundaries. The calculations are based on broad assumptions and estimates.

The dominant land use is agriculture

Agriculture is the dominant land use in the Arrowsmith and Jurien groundwater areas requiring water for stock and domestic needs, the main activities exempt from licensing. Agricultural practices change, affecting the level of water use. For example, recent drought years have lead to significant de-stocking in some areas. This methodology calculates the maximum water requirements for exempt activities rather than actual water use under current conditions.

Other sources of water

The Water Corporation provides non-potable water to rural areas through the Mingenew and Three Springs Rural Water Supply. This water is unaccounted for, as much of the area serviced lies outside the Arrowsmith groundwater area and as the purpose of the rural water supply is to supplement on-farm supplies, not to replace them.

Other water uses

Although the main land use is agriculture, large areas of native vegetation occur within some of the subareas. The Department of Environment and Conservation (DEC) were contacted in relation to water for fire fighting. Water is used opportunistically from farm dams, shire standpipes and some DEC bores. Contractors with water trucks are also used but it is not known where they obtain their water. The number of fire events that occur and the water used for each fire varies. As there is no water use information available, an estimate for fire fighting is

unlikely to be accurate. However, the transport of very large volumes of water is likely to be problematic due to its bulk and the distances that may be involved. Water use for fire fighting would not be consistently high enough to have long-term impacts on aquifer allocations.

Water for dryland cropping is a part of agricultural practices and is generally not licensed.

Assumptions

The adoption of any method will require the application of assumptions that reduce the accuracy of the estimate. In this case, an overestimation of use presents a lower risk.

- Stock and domestic calculations were made for agricultural areas, the assumption being that all town lots are supplied scheme water and residents do not directly access groundwater for exempt uses.
- Each individual agricultural property (identified by proprietor) was assumed to require only one domestic allocation, irrespective of size.
- The assumptions made for the calculation of an agricultural domestic allocation are explained in further detail below.
- The total area of cleared land was assumed to be agricultural land for the purposes of calculating stock and crop use.
- Lifestyle lots were those considered to be neither town lots nor agricultural; that is they could possibly be accessing water for stock and domestic use. The initial assumption was that only lots greater than 2 ha would be considered, also factoring in location and access to scheme water.
- The allocation for lifestyle lots was assumed to be half that calculated for agricultural properties, based on the assumption that not all would be accessing groundwater for exempt purposes or cultivating a 0.2 ha area of garden.

Data collection

- The numbers of individual properties (farms) per subarea were identified by the Department of Agriculture and Food Western Australia (DAFWA), who combined their property information with the groundwater subarea boundaries.
- The total area cleared was determined by DAFWA combining their vegetation information with the groundwater subarea boundaries.
- Estimates relating to area grazed versus cropping and the carrying capacity of agricultural land were also obtained from DAFWA for the calculation of stock and crop use.

Methodology

1 Calculating the number of agricultural properties

- The overlay of DAFWA property information with subareas produced lists of property numbers, proprietors, total property area and the area contained within the subarea.
- Properties not used for agriculture (identified by proprietor: DEC, shires, CBH, Westrail, caravan park etc) were removed from the list.
- Properties with approximately half their total area contained with the subarea were allocated half a domestic use, and where more than half of the property fell within the subarea a full domestic use was allocated.
- Where a proprietor held more than one property in a subarea, only one domestic use was allocated to the proprietor.

2 Calculating allocation for domestic and garden use on agricultural properties

- The allocation for domestic and garden use at agricultural properties was calculated as follows:

Domestic and garden average garden use:	Lawn	7500	kL/ha [#]
	Fruit trees	9000	kL/ha (based on citrus) [#]
	Native plants	5000	kL/ha [#]
	Vegetables	15 000	kL/ha [#]
	Average	9125	kL/ha

Average garden use 9125 x 0.2 ha = 1825 kL

Figure for household use = 150 kL/ house/ annum #

Estimated domestic and garden use = 2000 kL/ annum per property

[#] Figures from general water application rates, DAFWA.

3 Water for stock use

- The water use figure for stock was based on the general water application rate (DAFWA) for sheep, as when combined with carrying capacity, sheep use more water than cattle per hectare.
- Water use was calculated based on the area of cleared land and the estimated carrying capacity of stock numbers per hectare, as provided by DAFWA.

4 Water for crop use

- The assumption was made that crops would require three sprays per year using an average of 50 kL/ha, or 150 kL/ha/year.
- Water use was calculated based on this figure and the area of cleared land.

5 Lifestyle lots

- Lots larger than 2 ha were found to occur in and around the towns of Geraldton and Dongara (Dongara subarea) and the town of Jurien (Cervantes subarea). DAFWA data identified some of these properties. However, newer subdivisions have not been included.

- The cadastre layer in GIS was consulted and an estimate of lots > 2 ha was calculated for the Dongara and Cervantes subareas.
- In the Cervantes subarea, lifestyle lots were identified as those greater than 2 ha, located some distance from the Jurien town centre and not supplied with scheme water.
- In the Dongara subarea lifestyle lots were identified as lots 5 to 10 ha in size and some distance from the nearest town centre. Lots that ranged from 2–5 ha were not included as most occurred within suburbs of either Dongara or Geraldton and are supplied scheme water.

6 Finalising exempt allocations

- The regional hydrogeologist was consulted to determine the aquifers likely to be accessed in the different subareas for these exempt uses.
- Where more than one aquifer was identified within the subarea the total exempt use was allocated proportionally, as indicated, to each aquifer.
- Finally the margin of error estimated at 20% was also factored in – that is, exempt use in each aquifer was increased by 20% to allow for the inaccuracy of estimating the proportional use where more than one aquifer could be accessed.

Assigning an aquifer to the estimated use

Tables D1–D2 represents a summary of the probable aquifers being utilised for small volume abstractions for farm or residential use. The assumption is based upon a small supply < 250 m^3/day being abstracted from the most easily available aquifer, at the lowest cost. This equates to the major aquifer system across the subarea, which is nearest the surface and can supply the required volume and quality of water.

In each of these areas, it is considered that the aquifers listed provide approximately 70% of the small groundwater supplies, with Surficial/Superficial aquifers providing the remainder. Confidence in this desktop assessment as expressed by deviance (margin of error) is estimated at $^{+}$/- 20%.

Calculations

The final calculations for the estimation of exempt use is detailed in Table D3–D5.

Table D1 Aquifer allocated to exempt use for the Arrowsmith groundwater area

Subarea	Proportion	Aquifer
Tathra	All	Parmelia – Leederville aquifer
Mingenew	All	Parmelia – Leederville aquifer
Morrison	All	Parmelia – Leederville aquifer
Darling	West of the Darling Fault (60%)	Surficial aquifer
	East of the Darling Fault (40%)	Fractured/faulted rock
Allanooka	90%	Upper Yarragadee aquifer
	10%	Surficial aquifer (minor, limited)
Twin Hills	90%	Upper Yarragadee aquifer
	10%	Surficial aquifer (minor & limited)
Eneabba Plains	Northern $^{2}/_{3}$	Yarragadee aquifer
	Southern $^{1}/_{3}$	Superficial aquifer
Dongara	Southern $^{1}/_{3}$	Superficial aquifer
	Northern $^{2}/_{3}$	Yarragadee aquifer

Table D2 Aquifer allocated to exempt use for the Jurien groundwater area

Subarea	Proportion	Aquifer
Watheroo	Northern $^{3}/_{4}$	Fractured/faulted rock
	Southern $^{1}/_{4}$	Mirrabooka aquifer
Dinner Hill	Northern $^{1}/_{2}$	Leederville aquifer
	Southern $^{1}/_{2}$	Surficial aquifer
Badgingarra	All	Yarragadee aquifer
Nambung	All	Superficial aquifer
Cervantes	Western Edge	Superficial aquifer
	Eastern $^{2}/_{3}$	Lesueur aquifer

Table D3 Jurien and Arrowsmith stock and domestic calculations and estimations

Subarea	Subarea exempt use kL/yr	Aquifer	Proportion of exempt use %	Aquifer exempt use kL/yr	20% error margin	Total kL/yr	Rounded figure kL/yr
Cervantes	689 601	Superficial	33.3	229 637	45 927	275 565	280 000
		Lesueur	66.7	459 964	91 993	551 957	550 000
Nambung	310 558	Superficial	100	310 558	62 112	372 670	370 000
Badgingarra	781 392	Yarragadee	100	781 392	156 278	937 670	940 000
Dinner Hill	874 955	*Mirrabooka**	50	437 478	87 496	524 973	530 000
		*Leederville**	50	437 478	87 496	524 974	530 000
Watheroo	300 464	Fractured Rock	75	225 348	45 070	270 418	270 000
		*Mirrabooka**	25	75 116	15 023	90 139	90 000
Dongara	932 208	Yarragadee	66.7	621 783	124 357	746139	750 000
		Superficial	33.3	310 425	62 085	372 510	370 000
Allanooka	275 781	Yarragadee	90	248 203	49 641	297 844	300 000
		Surficial	10	27 578	5 516	33 094	35 000
Eneabba	326 877	Yarragadee	66.7	218 027	43 605	261 633	260 000
		Superficial	33.3	108 850	21 770	130 620	130 000
Twin Hills	896 791	Yarragadee	90	807 112	161 422	968 534	970 000
		Surficial	10	89 679	17 936	107 615	110 000
Mingenew	38 246	Leederville–Parmelia	100	38 246	0	38 246	40 000
Tathra	809 104	Leederville–Parmelia	100	809 104	0	809 104	810 000
Morrison	56 554	Leederville–Parmelia	100	56 554	0	56 554	60 000
Darling	490 494	Surficial	60	294 296	58 859	353 155	350 000
		Fractured Rock	40	196 197	39 239	235 437	240 000

**Requires review given current situation with allocation demand, licensed use, and aquifer location. Estimated exempt use for these aquifers has been assigned against the Surficial aquifer where the aquifer is listed as Mirrabooka in this table during the allocation limit decision-making.*

Table D4 Jurien groundwater area factors used in calculations

Factor	Subarea				
	Cervantes	**Nambung**	**Badgingarra**	**Dinner Hill**	**Watheroo**
Total area (ha)	82 998.29	73 726.94	131 803.17	170 294.18	42 782.54
Total property area	33 293.76	45 351.25	103 913.68	130 965.93	41 089.56
Number of domestic & garden allocations	28	26	83	88.5	35
Water required for domestic & garden (kL)	56 000	52 000	166 000	177 000	70 000
Number Lifestyle lots	507	0	0	0	0
Lifestyle lot use (kL)	507 000				
Total area cleared (ha)	18 652.08	38 093.23	90 665.47	102 829.54	33 954.22
Estimation of 25% cropping and 75% grazing					
Area cropped (ha)	4663.02	9523.31	22666.37	25707.38	8488.56
Water for cropping (kL)	699.45	1428.50	3399.96	3856.11	1273.28
Total area grazed (ha)	13 989.06	28 569.93	67 999.11	77 122.15	25 465.67
Estimation of carrying capacity 6 DSE/ha = 6 sheep @ 1.5 kL per annum requires 9 kL/ha					
Water for grazing (kL)	125 901.55	257 129.33	611 991.95	694 099.38	229 191.00
Total exempt water use	**689 601**	**310 558**	**781 392**	**874 955**	**300 464**

Table D5 Arrowsmith groundwater area factors used in calculations

Factor	Subarea							
	Dongara	**Allanooka**	**Eneabba**	**Twin Hills**	**Mingenew**	**Tathra**	**Morrison**	**Darling**
Total area (ha)	171 769.04	54 105.42	151 063.88	231 604.51	44 982.16	167 865.58	59 210.51	149 470.94
Total agricultural property area	68 985	52 931.06	66 199.68	187 330.76	39 719.8	153 606.05	14 566.99	113 421.31
No. of agricultural domestic & garden allocations	344.5	22.5	37	75	13	64.5	7	58
Water required for agricultural domestic & garden (kL)	689 000	45 000	74 000	150 000	26 000	129 000	14 000	116 000
Number Lifestyle lots	205	0	0	0	0	0	0	0
Lifestyle lot use (kL)	205 000	0	0	0	0	0	0	0
Total cleared area (ha)	8420.46	50 860.92	55 730.52	164 581.97	2698.93	149 885.19	9378.40	82 533.05
Estimation of 25% cropping and 75% grazing								
Area cropped (ha)	2105.11	12 715.23	13 932.63	41 145.49	674.73	37 471.30	2344.60	20 633.26
Water for cropping (kL)	315.77	1907.28	2089.89	6171.82	101.21	5620.69	351.69	3094.99
Total area grazed (ha)	6315.34	38 145.69	41 797.89	123 436.47	2024.20	112 413.89	7033.80	61 899.79
Estimation of carrying capacity 4 DSE/ha = 4 sheep @ 1.5 kL per annum requires 6 kL/ha								
Water for grazing (kL)	37892.06	228 874.14	250 787.33	740 618.85	12 145.18	674 483.36	42 202.80	371 398.72
Total exempt water use	**932 208**	**275 781**	**326 877**	**896 791**	**38 246**	**809104**	**56 554**	**490 494**

Assumptions use in the calculations:

Area cleared:

- Morrison – estimated through GIS
- Mingenew – estimated 6% vegetation cover (similar in appearance to Allanooka)
- Tathra – estimated by subtracting cleared area calculated for Morrison and Mingenew from Dandaragan total.

Lifestyle Lots:

- Over 2 ha and not included in DAFWA data (based on visual comparison of property map for Geraldton and Dongara and GIS)
    - Geraldton/ Greenough: 220 lots
    - Dongara: 98 lots
- Between 5 and 10 ha and not included in DAFWA data (based on visual comparison of property map for Geraldton and Dongara and GIS)
    - Geraldton/Greenough: 85 lots
    - Dongara: 0 lots
- From DAFWA database: 2 to 5 ha (235 lots); 5 to 10 ha (120 lots)
- Total lots for Dongara subarea between 5 and 10 ha (205 lots).

Appendix D — Water resource licensing database – November 2008

Arrowsmith groundwater area

Area												
Arrowsmith												
Sub-Area	Aquifer	Allocation Limit	Licenced Allocation	Stock and Domestic	% Allocated	Public Water Supply Reserve Commitments	Conditional Approval and Development Commitments	% Allocated and Committed	Additional Allocations Requested	Total Allocated Committed and Requested	% Allocated Committed and Requested	Balance Available for Future Licencing
Allanooka	Perth - Cattamarra Coal Measures North.	0	0	0	0.00%	0	0	0.00%	0	0	0.00%	0
	Perth - Surficial	0	0	0	0.00%	0	0	0.00%	0	0	0.00%	0
	Perth - Yarragadee North.	28,800,000	12,100,500	0	42.02%	8,000,000	0	69.79%	750,000	20,850,500	72.40%	7,949,500
Darling	Combined - Fractured Rock West - Fractured Rock	0	0	0	0.00%	0	0	0.00%	0	0	0.00%	0
	Perth - Cattamarra Coal Measures North.	400,000	0	0	0.00%	0	0	0.00%	0	0	0.00%	400,000
	Perth - Eneabba.	400,000	0	0	0.00%	0	0	0.00%	0	0	0.00%	400,000
	Perth - Fractured Rock	0	0	0	0.00%	0	0	0.00%	0	0	0.00%	0
	Perth - Leaueur Sandstone North.	1,400,000	0	0	0.00%	0	0	0.00%	0	0	0.00%	1,400,000
	Perth - Otorowiri.	0	0	0	0.00%	0	0	0.00%	0	0	0.00%	0
	Perth - Parmelia.	100,000	0	0	0.00%	0	0	0.00%	0	0	0.00%	100,000
	Perth - Surficial	2,500,000	5,000	0	0.20%	0	0	0.20%	0	5,000	0.20%	2,495,000
	Perth - Yarragadee North.	200,000	0	0	0.00%	0	0	0.00%	0	0	0.00%	200,000
Dongara	Northampton - Fractured Rock	0	0	0	0.00%	0	0	0.00%	0	0	0.00%	0
	Perth - Cattamarra Coal Measures North.	200,000	5,000	0	2.50%	0	0	2.50%	0	5,000	2.50%	195,000
	Perth - Eneabba.	0	0	0	0.00%	0	0	0.00%	0	0	0.00%	0
	Perth - Leaueur Sandstone North.	0	0	0	0.00%	0	0	0.00%	0	0	0.00%	0
	Perth - Superficial Swan	8,000,000	4,136,401	2,000	51.71%	1,000,000	118,800	65.69%	985,000	6,240,201	78.00%	1,759,799
	Perth - Surficial	0	0	0	0.00%	0	0	0.00%	0	0	0.00%	0
	Perth - Yarragadee North.	4,500,000	548,445	0	12.19%	0	0	12.19%	0	548,445	12.19%	3,951,555
Eneabba Plains	Perth - Cattamarra Coal Measures North.	100,000	0	0	0.00%	0	0	0.00%	0	0	0.00%	100,000
	Perth - Eneabba.	2,000,000	1,400,000	0	70.00%	0	0	70.00%	0	1,400,000	70.00%	600,000
	Perth - Leaueur Sandstone North.	1,800,000	470,000	0	26.11%	0	0	26.11%	0	470,000	26.11%	1,330,000
	Perth - Superficial Swan	14,600,000	227,190	0	1.56%	2,000,000	0	15.25%	2,500,000	4,727,190	32.38%	9,872,810
	Perth - Surficial	0	37,440	0	0.00%	0	0	0.00%	0	37,440	0.00%	-37,440
	Perth - Yarragadee North.	22,500,000	19,253,651	0	85.57%	1,000,000	27,800	90.14%	2,995,000	23,276,451	103.45%	-776,451
Mingenew	Perth - Fractured Rock	0	0	0	0.00%	0	0	0.00%	0	0	0.00%	0
	Perth - Otorowiri.	100,000	0	0	0.00%	0	0	0.00%	0	0	0.00%	100,000
	Perth - Parmelia.	8,200,000	852,500	0	10.40%	2,000,000	0	34.79%	14,000	2,866,500	34.96%	5,333,500
	Perth - Surficial	0	0	0	0.00%	0	0	0.00%	0	0	0.00%	0
	Perth - Yarragadee North.	0	0	0	0.00%	0	0	0.00%	0	0	0.00%	0
Morrison	Combined - Fractured Rock West - Fractured Rock	0	0	0	0.00%	0	0	0.00%	0	0	0.00%	0
	Perth - Cattamarra Coal	0	0	0	0.00%	0	0	0.00%	0	0	0.00%	0

Area												
Arrowsmith												
Sub-Area	Aquifer	Allocation Limit	Licenced Allocation		% Allocated	Public Water Supply Reserve Commitments	Conditional Approval and Development Commitments	% Allocated and Committed	Additional Allocations Requested	Total Allocated Committed and Requested	% Allocated Committed and Requested	Balance Available for Future Licencing
	Measures North.											
	Perth - Otorowiri.	100,000	0	0	0.00%	0	0	0.00%	0	0	0.00%	100,000
	Perth - Parmelia.	4,000,000	0	0	0.00%	500,000	0	12.50%	0	500,000	12.50%	3,500,000
	Perth - Surficial	0	0	0	0.00%	0	0	0.00%	0	0	0.00%	0
	Perth - Yarragadee North.	1,000,000	0	0	0.00%	0	0	0.00%	0	0	0.00%	1,000,000
Tathra	Perth - Cattamarra Coal Measures North.	50,000	0	0	0.00%	0	0	0.00%	0	0	0.00%	50,000
	Perth - Eneabba.	100,000	0	0	0.00%	0	0	0.00%	0	0	0.00%	100,000
	Perth - Fractured Rock	0	0	0	0.00%	0	0	0.00%	0	0	0.00%	0
	Perth - Lesueur Sandstone North.	100,000	0	0	0.00%	0	0	0.00%	0	0	0.00%	100,000
	Perth - Otorowiri.	0	0	0	0.00%	0	0	0.00%	0	0	0.00%	0
	Perth - Parmelia.	33,400,000	13,143,230	0	39.35%	2,000,000	5,109,000	60.64%	5,892,500	26,144,730	78.28%	7,255,270
	Perth - Surficial	0	2,500	0	0.00%	0	0	0.00%	0	2,500	0.00%	-2,500
	Perth - Yarragadee North.	700,000	0	0	0.00%	0	0	0.00%	0	0	0.00%	700,000
Twin Hills	Perth - Cattamarra Coal Measures North.	500,000	50,000	0	10.00%	0	0	10.00%	0	50,000	10.00%	450,000
	Perth - Eneabba.	400,000	0	0	0.00%	0	0	0.00%	0	0	0.00%	400,000
	Perth - Lesueur Sandstone North.	200,000	0	0	0.00%	200,000	0	100.00%	0	200,000	100.00%	0
	Perth - Otorowiri.	500,000	0	0	0.00%	0	0	0.00%	0	0	0.00%	500,000
	Perth - Parmelia.	3,400,000	0	0	0.00%	0	0	0.00%	0	0	0.00%	3,400,000
	Perth - Superficial Swan	0	0	0	0.00%	0	0	0.00%	0	0	0.00%	0
	Perth - Surficial	0	0	0	0.00%	0	0	0.00%	0	0	0.00%	0
	Perth - Yarragadee North.	48,800,000	9,338,250	0	19.14%	5,000,000	0	29.38%	20,600,000	34,938,250	71.59%	13,861,750

Jurien groundwater area

Area												
Jurien												
Sub-Area	Aquifer	Allocation Limit	Licenced Allocation	Stock and Domestic	% Allocated	Public Water Supply Reserve Commitments	Conditional Approval and Development Commitments	% Allocated and Committed	Additional Allocations Requested	Total Allocated Committed and Requested	% Allocated Committed and Requested	Balance Available for Future Licencing
Badgingarra	Perth - Cattamarra Coal Measures North.	400,000	154,800	0	38.70%	0	0	38.70%	0	154,800	38.70%	245,200
	Perth - Leederville - Parmelia.	300,000	0	0	0.00%	0	0	0.00%	0	0	0.00%	300,000
	Perth - Otorowiri.	700,000	0	0	0.00%	0	0	0.00%	0	0	0.00%	700,000
	Perth - Surficial	0	0	0	0.00%	0	0	0.00%	0	0	0.00%	0
	Perth - Yarragadee North.	27,500,000	1,413,333	0	5.14%	2,000,000	0	12.41%	10,000	3,423,333	12.45%	24,076,667
Cervantes	Perth - Cattamarra Coal Measures North.	100,000	0	0	0.00%	0	0	0.00%	0	0	0.00%	100,000
	Perth - Eneabba.	600,000	0	0	0.00%	0	0	0.00%	0	0	0.00%	600,000
	Perth - Leaueur Sandstone North.	3,000,000	0	0	0.00%	2,500,000	0	83.33%	3,000,000	5,500,000	183.33%	-2,500,000
	Perth - Superficial Swan	30,000,000	3,396,090	33,500	11.32%	10,000,000	0	44.65%	1,551,500	14,947,590	49.83%	15,052,410
	Perth - Surficial	0	0	0	0.00%	0	0	0.00%	0	0	0.00%	0
Dinner Hill	Combined - Fractured Rock West - Fractured Rock	0	0	0	0.00%	0	0	0.00%	0	0	0.00%	0
	Perth - Leederville - Parmelia.	12,600,000	8,953,230	0	71.06%	1,500,000	56,270	83.41%	7,065,000	17,574,500	139.48%	-4,974,500
	Perth - Mirrabooka	500,000	0	0	0.00%	0	0	0.00%	0	0	0.00%	500,000
	Perth - Otorowiri.	100,000	0	0	0.00%	0	0	0.00%	0	0	0.00%	100,000
	Perth - Surficial	3,200,000	20,000	0	0.63%	0	0	0.63%	0	20,000	0.63%	3,180,000
	Perth - Yarragadee North.	0	0	0	0.00%	0	0	0.00%	0	0	0.00%	0
Nambung	Perth - Cattamarra Coal Measures North.	1,600,000	0	0	0.00%	0	0	0.00%	0	0	0.00%	1,600,000
	Perth - Eneabba.	300,000	0	0	0.00%	0	0	0.00%	0	0	0.00%	300,000
	Perth - Leaueur Sandstone North.	2,700,000	0	0	0.00%	2,000,000	0	74.07%	0	2,000,000	74.07%	700,000
	Perth - Superficial Swan	4,000,000	2,700,000	0	67.50%	0	0	67.50%	0	2,700,000	67.50%	1,300,000
	Perth - Surficial	0	0	0	0.00%	0	0	0.00%	0	0	0.00%	0
	Perth - Yarragadee North.	8,800,000	2,500,000	0	28.41%	2,000,000	0	51.14%	0	4,500,000	51.14%	4,300,000
Watheroo	Combined - Fractured Rock West - Fractured Rock	0	70,000	0	0.00%	300,000	0	0.00%	0	370,000	0.00%	-370,000
	Perth - Leederville - Parmelia.	100,000	0	0	0.00%	0	0	0.00%	0	0	0.00%	100,000
	Perth - Otorowiri.	0	0	0	0.00%	0	0	0.00%	0	0	0.00%	0
	Perth - Surficial	900,000	80,000	0	8.89%	0	0	8.89%	0	80,000	8.89%	820,000
	Perth - Yarragadee North.	0	0	0	0.00%	0	0	0.00%	0	0	0.00%	0

Glossary

abstraction	The permanent or temporary withdrawal of water from any source of supply, so that it is no longer part of the resources of the locality.
allocation limit	Annual volume of water set aside for use from a water resource.
aquifer	A geological formation or group of formations capable of receiving, storing and transmitting large quantities of water.
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.
base flow	The component of stream flow supplied by groundwater discharge.
bore	An opening in the ground, normally vertical hole drilled in soil or rock, made or used to obtain access to underground water. This is equivalent to the description of a 'well' in *the Rights In Water and Irrigation Act 1914.*
consumptive use	Consumptive use includes water for licensing, stock and domestic use, and public water supply.
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.
discharge	The water that moves from the groundwater to the ground surface or above, such as a spring or the ocean. This includes water that seeps onto the ground surface, evaporation from unsaturated soil, and water extracted from groundwater by plants (evapotranspiration) or engineering works (groundwater pumping).
domestic bore	A bore used for providing the 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.
ecological water requirements	The water regime needed to maintain ecological values of water-dependent ecosystems at a low level of risk.
environmental water provisions	The water regimes that are provided as a result of the water allocation decision-making process taking into account ecological, social, cultural and economic impacts. They may meet in part or in full the ecological water requirements.
groundwater	The water that occurs in pore spaces and fractures in rocks beneath the ground surface. *See also* aquifer, confined aquifer and unconfined aquifer.
groundwater area	An area proclaimed under the *Rights in Water and Irrigation Act 1914* for the purposes of licensing and managing water use.
groundwater-dependent ecosystem	An ecosystem that is dependent on groundwater for its existence and health.
hydrogeology	The hydrological and geological science concerned with the occurrence, distribution, quality and movement of groundwater, especially relating to the distribution of aquifers, groundwater flow and groundwater quality.
licence (5C)	A formal permit which entitles the licence holder to 'take' water from a watercourse, wetland or underground source.
m AHD	Australian Height Datum (AHD) is the height in metres above mean sea level + 0.026 m at Fremantle.

non-artesian well	A well, including all associated works, from which water does not flow, or has not flowed, naturally to the surface but has to be raised, or has been raised, by pumping or other artificial means.
precautionary principle	Taking a cautious approach to development and environmental management decisions when information is uncertain, unreliable or inadequate.
public water supply reserve	Reservation of a volume of water to supply drinking water for human consumption.
recharge	Water that infiltrates into the soil to replenish an aquifer
salinity	The measure of total soluble salt or mineral constituents in water. Water resources are classified based on salinity in terms of total dissolved solids (TDS) or total soluble salts (TSS). Measurements are usually in milligrams per litre (mg/L) or parts per thousand (ppt).
social value	A particular in-situ quality, attribute or use that is important for public benefit, welfare, state or health (physical and spiritual).
social water requirement	Elements of the water regime that are needed to maintain social and cultural values.
stock bore	A bore that provides drinking water for stock.
subarea	A smaller area determined by the Department of Water within a proclaimed area used for water allocation planning and management purposes. The boundaries of which are based on the location of the water resource.
throughflow	The flow of water within an, and between, aquifers.
unconfined aquifer	Is the aquifer nearest the surface, having no overlying confining layer. The upper surface of the groundwater within the aquifer is called the watertable. The aquifer contains water with no upper non-porous material to limit its volume or to exert pressure.
watertable	The saturated water level of the unconfined aquifer. Wetlands in low-lying areas are often seasonal or permanent surface expressions of the watertable.
wetland	For the purposes of this plan (unless otherwise specified) the department adopts the Ramsar Convention definition of a wetland as *an area that is permanently, seasonally or intermittently waterlogged or inundated with water that may be fresh, saline, flowing or static, including areas of marine water of which the depth at low tide does not exceed 6 metres*.

Volumes of water

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

Shortened forms

CBH	Co-operative Bulk Handling Ltd
DAFWA	Department of Agriculture and Food
DEC	Department of Environment and Conservation
DWAID	Divertible water allocation inventory database
GDE	Groundwater-dependent ecosystem

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