



Department of Water
Government of Western Australia

Carnarvon Artesian Basin Water Management Plan

December 2007



Water Resource Allocation and Planning Series
Report no. WRAP 24



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Cover photograph

Artesian bore headworks, drilling rig and free-flowing bores within the Carnarvon Artesian Basin.

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Summary

The Department of Water (the department) manages and regulates Western Australia's water resources. To ensure that the groundwater resources of the Carnarvon Artesian Basin (Birdrong Aquifer) are allocated appropriately, the department has produced this water management plan.

The Carnarvon Artesian Basin (CAB) contains the Birdrong Aquifer, Western Australia's most geographically extensive artesian aquifer. Artesian groundwater from the Birdrong has historically been used by the pastoral industry but is under increasing demand from new development proposals.

While the resources of the Birdrong Aquifer are significant, recharge is limited. This means careful management is required to ensure that the quality of, and accessibility to, groundwater is not compromised.

This plan guides groundwater licence assessments and allocations within the CAB. The plan describes an impact management approach to assess new licence applications, which will protect existing users and their access to water. This means that new licences will only be approved if there is no unacceptable impact on existing, efficient water users.

1 Introduction

1.1 Purpose of this plan

The *Carnarvon Artesian Basin Water Management Plan* (the plan) presents an approach for sharing the Birdrong groundwater resource. The plan is focused on managing the impacts of groundwater abstraction to maintain any associated environmental and economic values. The Department of Water (the department) has developed this plan to provide information to organisations, industry and individuals about the way that groundwater in the Carnarvon Artesian Basin (CAB) will be managed.

This plan also supports the Gascoyne–Murchison Strategy, a regional initiative that aims to achieve a more sustainable use of groundwater in the CAB. This approach will have long-term benefits for the broader community of the Gascoyne Region, as it will enable further development by industries such as agriculture, aquaculture, tourism and mining.

This plan outlines the principles and policies to be used by the department to manage groundwater resources in the CAB.

The terminology of the Birdrong Aquifer and the Carnarvon Artesian Basin

The CAB is a significant geographical area. Underlying this area are several sources of confined or artesian groundwater associated with geological units (see Section 2.2). For the purposes of current resource management practices, these units and associated groundwater resources are referred to as the ‘Birdrong Aquifer’.

The phrase ‘Carnarvon Artesian Basin’ (CAB) is used when referring to water use and management in the geographic area covered by this plan.

The correct hydrogeological term, ‘Birdrong Aquifer’ (Birdrong), is used when referring to the resource where water is taken from.

Status of this plan

This is a final water management plan that the department, water users and proponents will implement and adhere to in making water management decisions.

The draft of this plan was published to promote discussion and debate before it was finalised. The department sought feedback on the content of the draft plan from water users, interested stakeholders and the general community. The department has considered all comments in preparing the final plan.

This plan is effective from December 2007 and will be reviewed in five years or earlier if required by the Minister for Water Resources.

1.2 Plan objectives

The objectives of this plan are to:

- (1) maintain pressure heads in the Birdrong sufficiently to allow pastoral users to operate efficient distribution systems

- (2) ensure that groundwater resources are allocated reasonably and used appropriately in the long term
- (3) prescribe the rules and protocols that will apply in the assessment of licence applications (and in the future, water resource development proposals, and the issue of groundwater resource entitlements)
- (4) prescribe monitoring requirements for the groundwater resource
- (5) inform the community about water resource management
- (6) clearly state the policies of the department relevant to the CAB.

1.3 Groundwater overview

Owing to the very low rainfall and intermittent runoff, groundwater is the main source of water in the CAB. Groundwater supports pastoral and horticultural properties, industry, mining, tourism, and town water supplies. The Birdrong Sandstone is the primary, most extensive and productive artesian groundwater source in the CAB. The Birdrong Sandstone outcrops (is at ground surface) in small areas on the eastern margin of the CAB and becomes deeper towards the coast, where it is typically 600 m below the surface. There are also a number of other aquifers, both above and below the Birdrong Sandstone, which are considered to be in some degree of hydraulic connection.

The department currently assigns all confined or artesian groundwater to the Birdrong groundwater resource (referred to in this plan as the 'Birdrong').

The shallow alluvial aquifer along the Gascoyne River at Carnarvon and the upstream part of the alluvial aquifer within the Gascoyne Groundwater Area are not considered to be part of the CAB. Neither are other shallow aquifers, such as the Wooramel River alluvium and the limestone aquifer at Cape Range.

1.4 Water allocation in Western Australia

The department is responsible for the allocation, management and regulation of water resources in Western Australia. The department manages the water resources of the state in consultation with other government agencies, key stakeholder groups and the community. The primary objectives of the department are to ensure the state's water resources are appropriately managed and used to support sustainable development and to protect water resources for the long-term benefit of the community. This is mainly achieved through a licensing and water allocation process.

Throughout the state, the department has ground and surface water areas and subareas that are proclaimed under the *Rights in Water and Irrigation Act 1914* (the RIWI Act). It is in these areas that the department issues water licences and allocates water. As part of the water allocation process, the department determines how available water will be shared between consumptive uses. Water management plans identify the water resources and water regimes to be protected, define the water licensing policy and formalise water management objectives for the area of application of the plan.

The area covered by a water management plan ranges in scale from regional to subregional to local. Local area plans may cover individual surface water or groundwater areas

or subareas. This plan can be considered as a sub-regional water management plan specifically for the Birdrong.

1.5 Legislative and policy framework

The role of the Department of Water

The department is responsible for allocating the state's water resources responsibly and managing their use to support sustainable development and protection of the environment. The department implements water allocation decisions and regulates the use of water through the powers assigned to it under the RIWI Act, the *Rights in Water and Irrigation Regulations 2000* and the *Water and Rivers Commission Act 1995*.

Rights in Water and Irrigation Act 1914

The primary legislation for allocating groundwater in Western Australia is the RIWI Act and the RIWI Regulations. The RIWI Act vests the 'right to the use and flow, and to the control, of the water at any time in any watercourse, wetland or underground water source' in the Crown (Part III, Division 1A, s.5A).

The RIWI Act requires compulsory licensing of all artesian wells (bores) throughout Western Australia. Artesian wells are defined in the RIWI Act as 'a well, including all associated works from which water flows, or has flowed, naturally to the surface' (Part I, s.2).

In addition, supplies from non-artesian wells within specific areas, proclaimed under the Act as groundwater areas, require licensing. These areas are proclaimed to make sure that they are allocated fairly among competing users, including the environment. The areas also protect existing and future users in areas of major public, agricultural, industrial or mineral developments.

Groundwater licence administration in the CAB is the responsibility of the department through the Mid-West Gascoyne Region's Carnarvon District office.

Water reform

Western Australia signed the National Water Initiative (NWI) agreement in April 2006. The overall objective of the NWI is to provide a 'nationally compatible, market, regulatory and planning based system of managing water resources in rural and urban settings that optimise economic, social and environmental outcomes' (page 3 of NWI). With the signing of the NWI there will be some changes in management and supporting legislation for water management, with a particular drive towards water trading. Considerable ongoing consultation with water users has already begun regarding these changes.

1.6 Carnarvon Artesian Basin

Location

The CAB has the largest area of artesian conditions of any aquifer in Western Australia. The basin is located along the coast in the state's mid-west region, extending from close to the Murchison River in the south to the mouth of the Fortescue River in the north (see Figure 1.1). The CAB area covers approximately 115,000 km² onshore and is predominantly in the

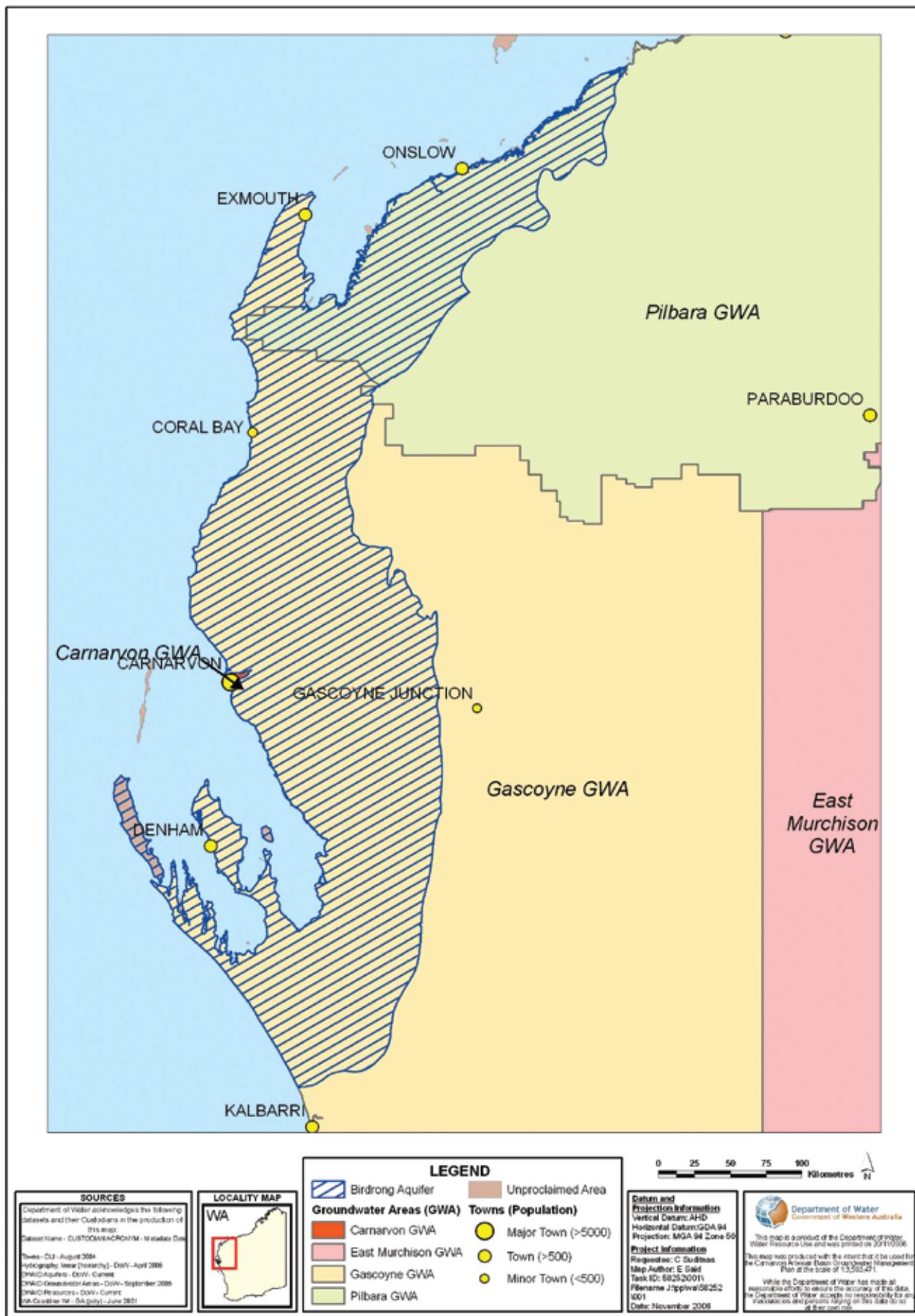


Figure 1.1 Proclaimed groundwater areas containing the Birdrong (CAB)

Zuytdorp/Ningaloo subarea of the Gascoyne Groundwater Area. It also extends some 300 km north into the Ashburton subarea of the Pilbara Groundwater Area. The CAB refers to the area where the principal aquifer, the Birdrong Sandstone, is present.

Artesian conditions exist over approximately 25,000 km² (more than 20 per cent) of the CAB. The majority of groundwater use from the Birdrong occurs in the Gascoyne Groundwater Area, with only one user currently in the Pilbara Groundwater Area.

Proclamation

The Gascoyne Groundwater Area was proclaimed on 16 December 1990 under the provisions of the RIWI Act, with proclamation variations on 21 December 1990 and 19 April 1991. The Gascoyne Groundwater Area is made up of several subareas. The subarea boundaries are not proclaimed under the RIWI Act and can therefore be changed by the department without the need for proclamation.

In June 2005, the Gascoyne Artesian Basin subarea boundary was changed to incorporate all of the Birdrong, as it previously included only the areas where natural artesian flow occurred. The amended subarea was renamed Zuytdorp/Ningaloo and included the majority of artesian and subartesian bores that abstract from the Birdrong. The remaining northern portion of the CAB is located within the Ashburton subarea, in the Pilbara Groundwater Area. The Pilbara Groundwater Area was proclaimed on 12 February 1965.

History

Since the early 1900s, more than 170 artesian bores have been constructed in the CAB, principally to serve the pastoral industry. Some of these bores were originally drilled for exploration purposes (eg for coal) and later given to pastoralists as a reliable water supply. Most of the original bores in the CAB were uncontrolled, flowing into open drains where the water cooled and was used by stock. As a consequence, an estimated 95 per cent of this water was lost to evaporation or seepage into the ground (DoE 2004). The majority of the early bores also deteriorated rapidly, causing leakage into the overlying saline aquifers. As a result of unsparing water use and the poor construction materials used in the past, many artesian bores have now ceased to flow naturally to the surface due to bore leakage and decreased artesian head.

1.7 Carnarvon Artesian Basin Rehabilitation Project

The Carnarvon Artesian Basin Rehabilitation Project began in 1998 as part of the Gascoyne–Murchison Strategy. It aimed to cap and pipe the free-flowing artesian bores used by pastoralists. The project is voluntary and aims to encourage pastoralists to rehabilitate their bores and reticulate their bore drains to restore the natural artesian head. Other significant benefits of the project include the ability to construct total grazing management yards to help improve production, control and domesticate feral animals; and provide the opportunity for pastoralists to diversify into other enterprises, such as aquaculture and intensive horticulture. The works are subsidised by the Australian Government (40 per cent) and Western Australian Government (40 per cent), with the remaining 20 per cent paid by the participating pastoralist.

The first stage of the project led to the decommissioning or rehabilitation of 55 artesian bores. This saved approximately 8.22 GL¹ per year of water reaching the surface. However, the amount of subsurface leakage that has been saved by decommissioning the bores is likely to have been considerably higher, possibly up to 55 GL/year. The first stage of the project also saw the removal of more than 88 km of open-bore drains and the construction of 15 new artesian bores. As a result, artesian heads have stabilised and increased in some areas. The second stage of the project has recently begun. It aims to decommission another 28 free-flowing bores, drill 10 new replacement bores and potentially decommission 20 non-flowing bores by mid 2008. This will further reduce groundwater wastage and increase the artesian head in the Birdrong.

The department (previously Water and Rivers Commission) and participating pastoralists identified principles in relation to the licensing and allocation of groundwater in the CAB. The principles aimed to provide more certainty for pastoralists to maintain their rights to the water resource, despite the rehabilitation and decommissioning of their artesian bores. Given this, it is important to note that all groundwater users in the CAB are subject to the licensing requirements under the RIWI Act and the principles of the NWI signed by the state government in 2006. A licence entitlement, based on actual usage, will be included on all groundwater licences in the CAB for management and administrative purposes.

¹ 1 gigalitre (GL)=1000 megalitres=1 million kilolitres=1 billion litres

2 The physical environment

2.1 Climate

The Carnarvon Artesian Basin (CAB), as part of the Gascoyne Region, extends either side of the Tropic of Capricorn and has a moderate arid climate. The region experiences hot, dry summers (more humid along the coast) and mild winters, receiving 320 days of sunshine annually (GDC 2006). The inland areas experience more extreme variation between summer and winter temperatures than the coastal areas. In summer, the average maximum ranges from 32 to 35°C and the average winter minimum ranges from 9 to 11°C (BOM 2006).

Rainfall across the Gascoyne Region is low, mostly averaging 200 mm per year and slightly more around the Exmouth area and to the south of Shark Bay (BOM 2006). Most rainfall is received between May and July. In summer, rainfall may originate from cyclonic activity from the north and is therefore variable over time and locality.

Annual evaporation across the region is approximately 2,400 mm (BOM 2006), which far exceeds the region's total annual rainfall. This limits the suitability of surface water resources and increases the reliance on groundwater resources.

2.2 Hydrogeology

There are six significant geological formations in the CAB that produce useful supplies of groundwater. From youngest to oldest in age (therefore, shallowest to deepest), these are:

1. Windalia Radiolarite
2. Windalia Sand Member
3. Birdrong Sandstone
4. Nanyarra Sandstone
5. Kopke Sandstone
6. Tumblagooda Sandstone.

The CAB is considered to be the area occupied by the Birdrong Sandstone, which is the main artesian aquifer, and which covers the western part of the Carnarvon Sedimentary Basin. The western part of the Carnarvon Sedimentary Basin contains a mostly shale or clay sequence of Cretaceous age overlain by Cainozoic limestone. The base of the Cretaceous sequence is the Birdrong Sandstone, which unconformably overlies a variety of older sedimentary rocks. These range from Ordovician to Permian age, with Jurassic strata present in the core of the Woodleigh impact structure.

The hydrogeology of the Carnarvon Sedimentary Basin was described by Allen (1987) and updated in the southern part by Wills and Dogramaci (2000). Recharge to the Birdrong Sandstone Aquifer is restricted to areas of outcrop, such as the Kennedy Range, and favourable structures where groundwater can recharge through other formations, such as at Rocky Pool on the Gascoyne River and the eastern boundary of Meedo Station close to the Wooramel River. Groundwater from the Birdrong Sandstone Aquifer can also flow into the underlying sedimentary rocks, where they are sufficiently permeable. The aquifer

is confined by the overlying shales, giving rise to extensive areas of natural artesian conditions along the coast north of Hamelin Pool. Allen (1987) indicates that the maximum natural artesian head may have been around 60 m AHD (Australian Height Datum) in the Hamelin Pool area, but is currently around 40 m AHD (URS 2007).

Groundwater salinity in the confined aquifers is relatively high (see Figure 2.1). Fresh groundwater is restricted to areas of recharge, with the groundwater becoming brackish downstream. The major area of brackish groundwater (1,000–3,000 mg/L total dissolved salts - TDS) occurs southwest of Kennedy Range, extending to Shark Bay. Elsewhere the groundwater is saline (exceeding 3,000 mg/L) with particularly high salinity (>12,000 mg/L TDS) in the southeast of the CAB, and along the coast, northeast of Cape Range. Owing to the depth of the aquifer and the high geothermal gradient across the shale sequence (5°C/100 m), the groundwater temperature ranges from 32 to 62°C (DoE 2004).

The Tumblagooda, Kopke and Nannyarra Sandstones are directly overlain by, and connected to, the Birdrong Sandstone in places. The Windalia Sand and Windalia Radiolarite, however, form a discrete system above the Birdrong, which may be hydraulically separate.

Since groundwater recharge to the Tumblagooda, Kopke and Nannyarra Sandstones can only take place by leakage from the Birdrong Sandstone, and any groundwater abstraction from those formations will affect potentiometric head in the Birdrong Sandstone, it is convenient to consider them as a single connected system, known as the Birdrong Aquifer. Currently the Windalia Radiolarite and Sand Member is also included, as there is insufficient information to justify management as a separate resource.

Windalia Radiolarite and Windalia Sand Member

The Windalia Radiolarite outcrops locally along the eastern areas of the CAB just to the west of the Birdrong Sandstone, while the Windalia Sand is restricted to the area south of Shark Bay. The thickness varies from less than 25 m in the south to more than 250 m in the north.

Wills and Dogramaci (2000) refer to many bores in the Windalia Radiolarite, both free-flowing and non-flowing, and typical groundwater salinity of 4,000 to 10,000 mg/L TDS in the Windalia Radiolarite and around 7,000 mg/L in the Windalia Sand.

Birdrong Sandstone

The Birdrong Sandstone aquifer is present throughout the CAB and outcrops in the eastern areas where groundwater recharge is likely to occur, although the quantity of recharge is considered minimal. The Birdrong Sandstone occurs at less than 200 m deep around the Hamelin Pool area (Wills and Dogramaci 2000), and exceeds 1,000 m depth at Exmouth (Allen 1987). The sandstone is typically 20 to 30 m thick and contains the majority of bores in the CAB, particularly to the north of Carnarvon, where it appears to be the shallowest and most predictable aquifer.

Groundwater from the Birdrong is mainly brackish, although the salinity depends greatly on location. For example, water quality in the Birdrong Sandstone at Edaggee and Callagiddy stations is around 2,900 mg/L TDS. It exceeds 12,000 mg/L TDS around Exmouth and

Onslow and in the southeast. Many of the bores in the Birdrong Sandstone are free flowing and still produce substantial flow rates of up to 6,000 kL per day. The direction of groundwater flow in the aquifer is westerly with groundwater salinity increasing along the flow path (towards the coast). At Meedo Station, the groundwater is fresh (<1,000 mg/L TDS) due to recharge from the Wooramel River.

Nannyarra Sandstone

The Nannyarra Sandstone unconformably underlies the Birdrong Sandstone in the Carnarvon–Lake McLeod area and has a maximum known thickness of 190 m. The top of the aquifer has a minimum depth of 200 m. The aquifer is potentially in hydraulic connection with the Birdrong Sandstone, but has not been identified as contributing to existing water bores.

Kopke Sandstone

Underlying the Birdrong Sandstone in the Shark Bay Region is the Kopke Sandstone. The Kopke Sandstone can be found at a minimum depth of 250 m immediately north of the Wooramel River and is up to 415 m thick (Wills and Dogramaci 2000). This sandstone does not outcrop in the basin.

The Kopke Sandstone is a potentially significant groundwater source for the Shark Bay to Carnarvon area where the salinity of the aquifer is as low as 2,000 to 3,000 mg/L TDS (Wills and Dogramaci 2000). South of Shark Bay, however, salinity is about 10,000 mg/L TDS and groundwater salinity also increases with depth. Many bores in this area had previously been considered to be producing from the Tumblagooda Sandstone but Wills and Dogramaci (2000) have reinterpreted the aquifer to be the Kopke Sandstone.

Tumblagooda Sandstone

The Tumblagooda Sandstone is the oldest sedimentary rock unit in the CAB. It is separated from the Kopke Sandstone by the relatively impermeable Dirk Hartog Group, and outcrops along the Murchison River. The aquifer is found at depths of 1000 m or more, is up to 3,500 m thick, and overlies granite basement (Wills and Dogramaci 2000). Not many bores are drilled into the Tumblagooda Sandstone due to the depth. Storage is unknown; however, the aquifer is likely to hold a large amount of water due to its thickness.

Table 2.1 Summary of the significant hydrogeological units in the Carnarvon Artesian Basin strata (collectively referred to as the Birdrong Aquifer)

Aquifer	Thickness	Minimum depth	Salinity (mg/L TDS)	Use
Windalia Radiolarite	0–15 m (at Yaringa)	Shallowest brackish aquifer	4,000–10,000	Non-flowing and flowing wells, pastoral south of basin
Windalia Sand Member	0–32 m (at Coburn)	Only occurs near Hamelin and Coburn stations	6,500–7,000	Pastoral
Birdrong Sandstone	20–30 m	<200 m near Hamelin Pool to >500 m at Carnarvon Outcrops along eastern margin of Gascoyne Platform	<1,000 to >12,000	Pastoral; whole CAB; town water supply for Denham, Useless Loop, Coral Bay; Mining at Lake MacLeod
Nannyarra Sandstone	190 m max.	200 m, outcrops northeast of Carnarvon	–	Not used
Kopke Sandstone	Up to 415 m	300–500 m near Shark Bay, <250 m north of Wooramel, ~ 550 m near Carnarvon	2,000–3,000 where shallow, 10,000 south of Shark Bay	Pastoral, mainly used between Wooramel and Gascoyne Rivers, also Shark Bay and Carnarvon
Tumblagooda Sandstone	3,500 m	~1,000 m outcrops along Murchison River and in Kalbarri Region	Brackish — saline north of the Murchison River	Pastoral

CAB=Carnarvon Artesian Basin; TDS=total dissolved salts

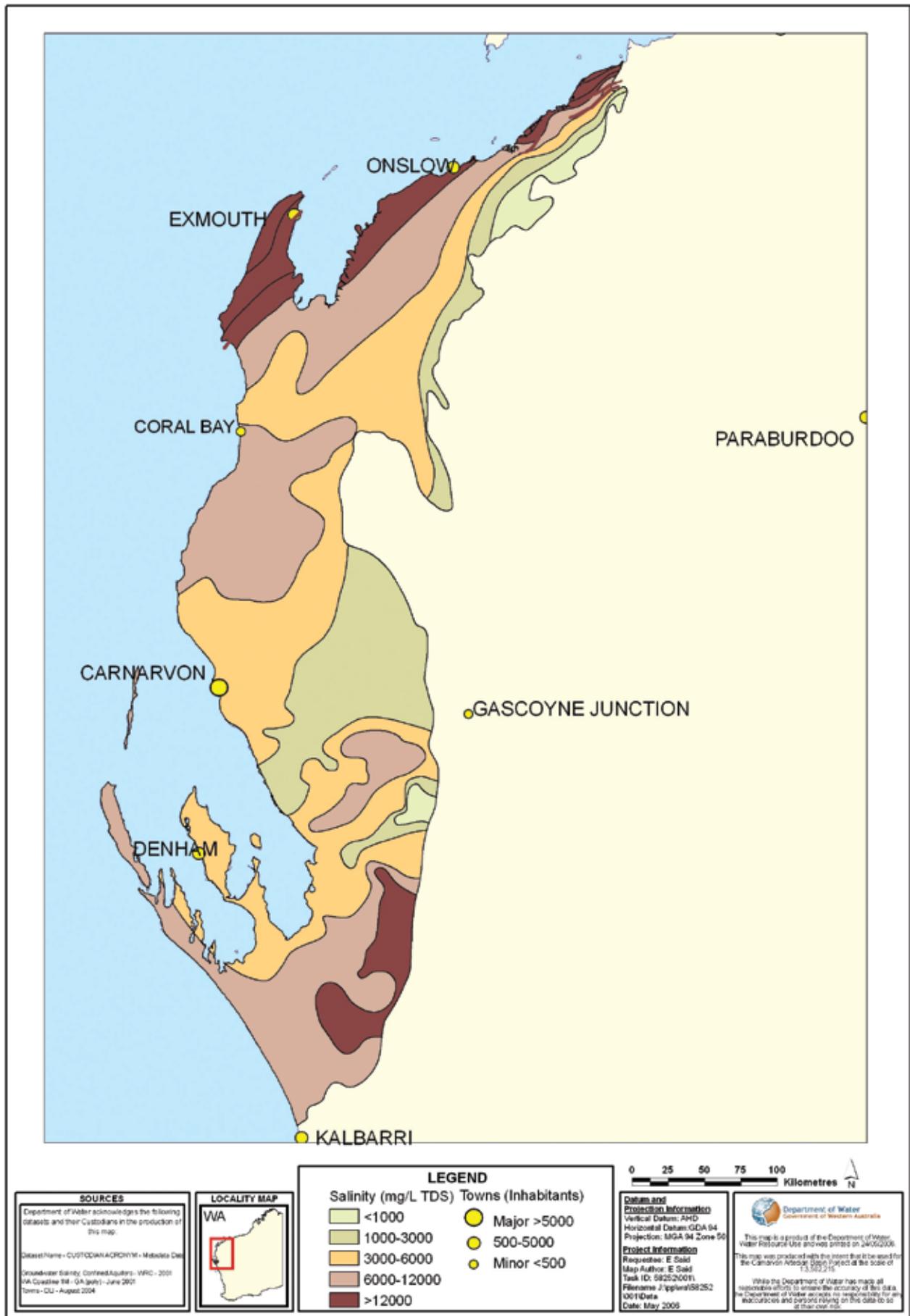


Figure 2.1 Groundwater salinity (total dissolved salts) in the Birdrong

3 Ecological, social and economic considerations

3.1 Sustainable use of water

The goal for managing the Carnarvon Artesian Basin (CAB) is to ensure that impacts on values that depend on the resource are acceptable. Abstraction from the Birdrong will alter the artesian head levels of the groundwater system. Therefore, appropriate measures (such as efficient water use, monitoring, and precautionary levels of allocation), must be implemented for the most effective use of the groundwater resource. Current and future developments will use best management practices to minimise possible effects on the Birdrong and its existing users, including long-term drawdown impacts and subsequent declines in artesian head.

Groundwater-dependent ecosystems

The department considers that there are no natural groundwater-dependent ecosystems within the CAB because of the depth of the aquifer system. However, at some bore sites there are artificial water bodies created by both free-flowing and controlled artesian bores. These have led to the establishment of numerous water-dependent species, both flora and fauna (weeds, feral animals, etc). For the purposes of protection, these artificial wetlands are not considered by the department to have environmental values. Bore owners are not permitted to use CAB groundwater to maintain wetland water levels or to discharge groundwater into bore drains without an associated groundwater licence specifying this usage. The Carnarvon Artesian Basin Rehabilitation Project, which involves the decommissioning of bores and reticulation of water, will result in the removal of artificial wetlands and associated bore drains.

Social and cultural values

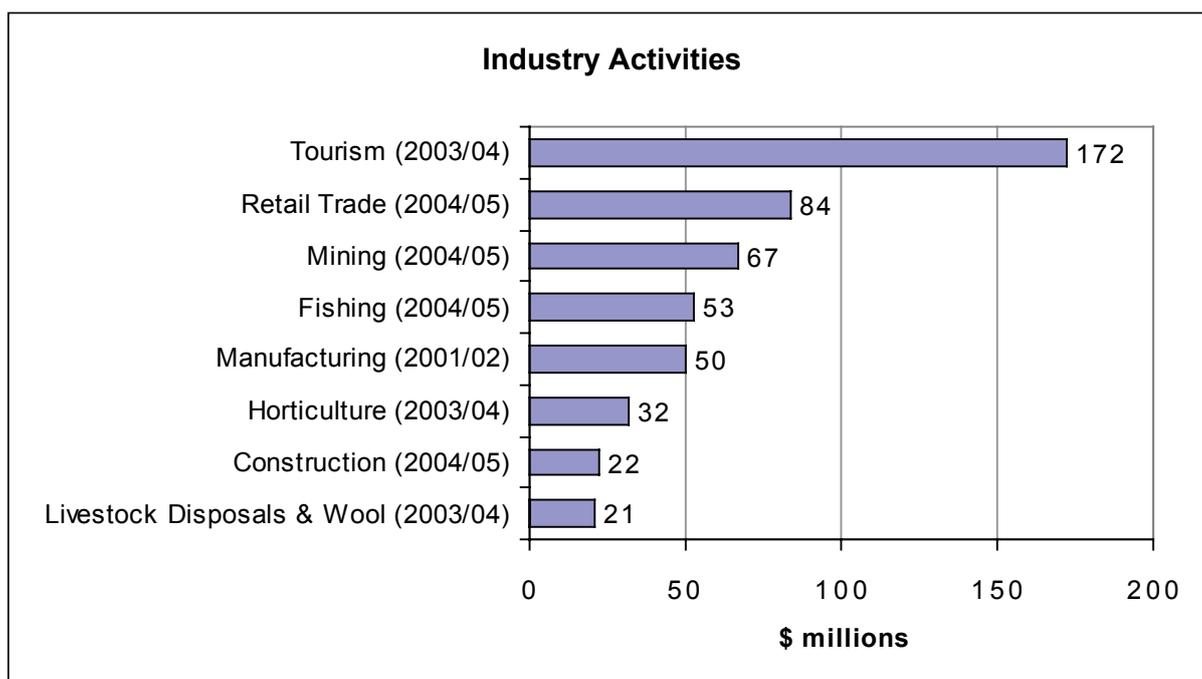
The CAB has very few associated social and cultural values. Some social values that rely on CAB groundwater include the Bibbawarra bore and the Peron Station hot tubs, which support conservation work by the Department of Environment and Conservation (Western Australian Government). For the purpose of this plan, no cultural values are considered to depend on groundwater of the Birdrong.

In Denham, on the Department of Environment and Conservation-managed Peron Station, hot tubs were constructed to take advantage of the warm artesian water, which is approximately 44°C. These hot tubs, located at the Peron Homestead, are an attraction for more than 30,000 tourists each year and local residents using the nearby recreational facilities. The water also supports ongoing conservation activities but this is not reliant on artesian pressure in the aquifer. In the assessment of potential impacts of new licensees, the Peron Station bores will be recognised in the groundwater model to avoid impact on this social value.

3.2 Economic significance

Water from the CAB supports much of the economic development in the Gascoyne Region as it is the major available water resource. Although the following information identifies economic values for the Gascoyne Region as a whole, they reflect a reasonable estimation

of the economic importance of the CAB. The major contributors to the economy of the Gascoyne Region are tourism, retail trade, mining, fishing, manufacturing, pastoralism and horticulture (see Figure 3.1). The Gascoyne Region gross product for 2004/05 was estimated at \$538 million, which is 11.9 per cent higher than the previous year (DLGRD 2006). With diverse industry activity and high productivity, the region is thriving. The Birdrong is the main source of groundwater in the region and industries rely on the CAB for new and existing enterprises. There is some water (estimated eight GL/year) drawn from the alluvial aquifer, generally for local use with only local impacts.



Note: Industry activities are based on value of production, turnover and expenditure whereas gross regional product is the value of final goods and services produced in the region less intermediate inputs.

Figure 3.1 Value of industries in the Gascoyne Region (DLGRD 2006)

Tourism

The tourism industry has grown rapidly and is very important to the Gascoyne Region. It is currently the largest contributor to the region's productivity, with the industry producing \$172 million in 2003/04 (see Figure 3.1). Unique natural areas within the Gascoyne Region are the primary attractions for tourists. These include the Cape Range National Park, Ningaloo Marine Park and Shark Bay (DLGRD 2006), one of Western Australia's two World Heritage properties. Wildlife within these areas, especially marine life on the coast, attracts more and more national and international tourists to the region every year. The increase in tourism has led to increased demand on the CAB groundwater for the town water supply at Coral Bay and Denham. Further demands will also be likely in the Nanga and Monkey Mia as the Gascoyne Development Commission (GDC) promotes the further development of the tourism capacity in these towns.

These towns rely on tourism as a major source of income.

Agriculture

Agriculture in the Gascoyne Region is predominantly pastoral and horticultural. In 2003/04 the agricultural sector was valued at approximately \$54 million - \$32 million from horticulture and \$21 million from pastoral production (DLGRD 2006). The region contains 139 agricultural holdings (including horticultural and pastoral), which cover an area of 13.6 million ha. Their production relies largely on the price of wool and meat. The majority of the region's horticultural production is situated along the Gascoyne River, using water from alluvial aquifers for irrigation. Other than these horticultural properties, many pastoral properties situated within the CAB rely on artesian water resources. The artesian water is generally brackish to saline and therefore usually suitable only for stock, but may be used for salt-tolerant crops.

Pastoral activities are long established in the region, with sheep being introduced in 1876. The GDC states that 'pastoral stations represent more than just an industry to the people of the Gascoyne, but a way of life chosen by a unique group of Gascoyne residents' (GDC 2006). Wool and meat productions are the primary activities on most pastoral properties; however diversification by many enterprising stations is occurring.

Where water is available and subject to Department of Planning and Infrastructure land assessment, stations may diversify their operations. Through diversification permits, stations can take advantage of opportunities in activities such as 'goat domestication, horticulture, inland aquaculture and outback tourism' (GDC 2006). These activities are currently present in the Gascoyne Region as only small operations. The GDC is supportive of businesses expanding and diversifying into new markets; however, future diversification options may be limited by access and availability of water. The high-quality artesian wells constructed during the Carnarvon Artesian Basin Rehabilitation Project have provided more control and security of water supply for some CAB users, and therefore made diversification viable. Diversification of pastoral stations into horticulture, aquaculture and tourism will provide station owners and the Gascoyne Region with significant economic returns.

The goat and table grape industries are two major sectors in the Gascoyne Region that are expanding. Table grape production was introduced to the region in 1992 and was estimated to have a gross value of \$8.7 million in 2005 (DLGRD 2006). It is anticipated that the industry could produce as much as \$10 million per year where the available groundwater is fresh to marginal. The goat industry is also young and is continuing to develop since the first consignment of live Boer cross goats to Malaysia in 1997 (DLGRD 2006). There are approximately 8,000 domesticated goats in the Gascoyne Region. Both domesticated and feral goats are sold for meat or live export to South East Asia and the Middle East (DLGRD 2006). The capture of feral goats is made easier by controlling and reticulating groundwater into stock watering points in total grazing management yards - another benefit of the Carnarvon Artesian Basin Rehabilitation Project.

Mining

In 2004/05, mineral production in the Gascoyne Region was valued at \$67.1 million, of which, 70 per cent was from the salt industry and almost 30 per cent was from gypsum production (DLGRD 2006). Currently, the region contributes more than 20 per cent of the total value of Western Australia's salt production. Salt production in the region comes from

mining at Lake MacLeod (by Dampier Salt) and Useless Loop (operated by Mitsui). The Lake MacLeod salt mine draws groundwater from the underlying CAB, which is used to wash impurities from the salt and to maintain the operational plant. A substantial salt mine is also proposed in the Exmouth Gulf, which would likely require CAB groundwater for its operations.

Dampier Salt also has the Gascoyne Region's only gypsum operation situated next to its salt project at Lake MacLeod. The operation started in 1997 and in 2004/05 produced 1.1 million tonnes of gypsum with an estimated value of \$19.5 million (DLGRD 2006). This accounts for 85 per cent of the value of Western Australia's gypsum production. The mined gypsum at Lake MacLeod is processed (classified) on a floating dredge and then leached in stockpiles using CAB groundwater to reduce impurity levels and produce a saleable product (Dampier Salt Limited 2006).

A significant mineral sands operation is planned in Coburn (immediately southeast of Denham/Shark Bay). The proposed mine would operate for 18 years, and produce a total revenue estimated at \$1.3 billion (GRL 2006). An application for a substantial groundwater allocation has been lodged to develop the mine. Groundwater extracted from the Birdrong and Kopke Aquifers is proposed to be used for transporting ore from the pit, mineral concentration, domestic use and dust suppression (EPA 2005).

4 Groundwater allocation, availability and use

4.1 Allocation limits

There are no identified natural groundwater-dependent ecosystems linked to the Birdrong, so the main management objective is to maintain the availability of artesian head levels for existing users. As groundwater recharge in the Birdrong is considered to be minimal, groundwater abstraction may cause progressive long-term lowering of artesian head levels.

Before the Carnarvon Artesian Basin Rehabilitation Project, there was a substantial reduction in potentiometric head due to unmanaged free-flowing artesian bores. This reduced head did not have any significant effect on current water users or other values but continuing decline was identified as an issue and the rehabilitation project was implemented.

The pre-rehabilitation level of potentiometric head from the Carnarvon Artesian Basin (CAB) has been identified as acceptable, provided there is no further decline. Therefore, the department will accept some reduction in current, post-rehabilitation potentiometric head, provided that it does not decrease below the level reached before the Carnarvon Artesian Basin Rehabilitation Project.

The department will adopt an impact management approach for the Birdrong in the Zuytdorp/Ningaloo subarea of the Gascoyne Groundwater Area by managing the decline in artesian head levels. This approach will support sustainable development of the resource. It takes into account social, ecological and economic aspects, although there are few social and ecological considerations in the CAB.

This impact management approach is similar to that currently used in areas of fractured rock aquifers. Applications for groundwater licences will be assessed primarily by their potential impacts on existing users. Current knowledge is insufficient to set a precise allocation limit in advance of abstraction. However, to administer licensing in the CAB, the department will continue to maintain a nominal allocation limit.

This nominal limit will be set so that current licensed use will constitute 70 per cent of the allocation limit. The limit will be adjusted upwards when new licences are approved (subject to the rules and assessment described in this plan). When the department considers that the availability of water to current water users could be impacted then the allocation limit will be fixed and no further licences for new water permitted. Trading will then be introduced after consultation with the community.

The current allocation limit of the Birdrong Groundwater Resource in the Zuytdorp/Ningaloo subarea (Gascoyne Groundwater Area) is set at 30 GL/year. This figure was determined through expert review of the aquifer, the application of the regional groundwater model and the results of technical investigations by proponents as required through the licence assessment process.

4.2 Groundwater use

As at 23 November 2006, there were 7,429,560 kL/year licensed entitlements in the Birdrong groundwater resource (Zuytdorp/Ningaloo subarea). There were also 20,495,850 kL/year of additional requested allocations from four applications currently being assessed by the department. In accordance with the impact management approach, the department may issue these additional groundwater licences if the proposed abstraction will not cause unacceptable impacts on the resource and other users. Once issued, the allocation limit will be amended accordingly (see Sections 4.1 and 5.1 - principle 9). Refer to Section 5 for the department's policy and process for assessing groundwater licences in the CAB.

Due to the significant area of the CAB requiring surveying, the historic non-licensed use before proclamation, and the previous absence of a comprehensive metering policy, groundwater use in the CAB cannot be quantified accurately. As a part of the Carnarvon Artesian Basin Rehabilitation Project, many bores were decommissioned and new bores were drilled, with each given an associated groundwater licence. To improve the management of the resource and to avoid prosecution, all artesian bores must be licensed under the *Rights in Water and Irrigation Act 1914* (see Section 5.1).

The current licensed use of groundwater can be divided into five main categories relating to the user: mining and industry, pastoral stations, public water supply, public services and commercial (other). The amount of licensed usage in the CAB is shown in Figure 4.1.

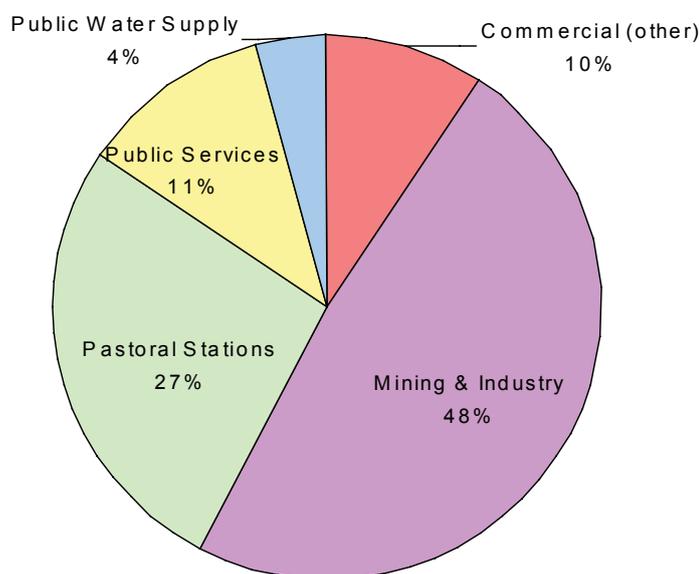


Figure 4.1 Licensed groundwater use in the Birdrong Aquifer by user categories, with total allocation of 7,099,560 kL/year (as at 2 March 2006)

The greatest use of groundwater in the CAB is for mining and industrial purposes. This comprises approximately 98.5 per cent of water use for salt and gypsum mining, and 1.5 per cent for the maintenance of the gas pipeline. Mining is considered an important industry for the economic growth of the Gascoyne Region. Groundwater use for mining and industry purposes is likely to increase in the future with proposed development in Coburn and continued exploration in the region.

Pastoral stations have a total allocation of 1,926,560 kL/year of CAB groundwater for stock watering, horticulture and aquaculture developments. As a result of the Carnarvon Artesian Basin Rehabilitation Project, groundwater use on pastoral stations has decreased significantly, with the decrease in bore drains and subsequent increase in efficient water use. However, actual water use on pastoral stations is likely to be significantly higher than the total allocated figure. This is as a result of numerous stations operating without a groundwater licence or using quantities greater than their licence permits. With future licensing and decommissioning through the Carnarvon Artesian Basin Rehabilitation Project, water use efficiency and determination will improve.

Groundwater use for public services (parks, gardens, recreational facilities, etc), commercial (caravan parks, resort facilities, etc) and public water supply, make up the remainder of licensed users in the CAB. Groundwater use for public services and commercial enterprise is an important economic contributor as they support tourism and growth in the Gascoyne Region. Public water supply is also an important use of groundwater, supporting populations in Coral Bay, Denham and Useless Loop. As these town populations increase, the allocation of water for public water supply will also increase from the current 300,000 kL/year.

Current and proposed management response in the Birdrong Sandstone Aquifer

The Birdrong Sandstone is currently used at 25 per cent of total allocation. In line with the impact management approach of this plan, there will need to be steps taken to ensure efficiency of all users and good accounting for water resource use. The department aims to achieve this by implementing the following:

- license all bores and their use
- develop a licensing policy specifically to manage the impacts on artesian head pressure in the CAB
- consult with the Carnarvon Artesian Basin Rehabilitation Project advisory group to progress the second stage of the project
- consider the need to establish a Gascoyne advisory group to provide advice on policy decisions and groundwater management in the Gascoyne
- improve water use efficiency and reduce unlicensed groundwater use in the CAB (through the Carnarvon Artesian Basin Rehabilitation Project)
- increase monitoring requirements of licensees and compliance surveys by the department.

4.3 Future use

With ongoing development in the Gascoyne Region, use of groundwater from the CAB will increase, particularly through town water supply, mining and diversification of pastoral stations. The use of CAB groundwater for town water supply is also likely to increase as a result of a growing tourism industry. This is especially likely in Denham and Coral Bay where the Birdrong is currently used to supply water to the towns as well as future use in Monkey Mia and Nanga. The Water Corporation has recently begun construction of an artesian bore and associated infrastructure for treating and delivering town water to Coral Bay. This water supply will involve the cooling and desalination of the hot Birdrong groundwater (DLGRD 2006).

5 Allocation principles and licensing considerations

5.1 Carnarvon Artesian Basin licensing policy

Position statement

The department will not support applications to take groundwater or to change the location of groundwater abstraction in the Carnarvon Artesian Basin (CAB), where the proposed abstraction may unacceptably impact upon existing users and their access to water.

Objectives

The main objectives of licensing groundwater abstraction from the CAB are to:

- assist sustainable development in the region while minimising the impacts of existing and future abstractions on potentiometric head levels in the CAB
- ensure that future use of artesian groundwater does not cause declines in artesian head levels in existing bores to a point where water availability to existing users is compromised
- ensure water availability for future drinking water supply to regional towns and communities.

This plan provides guidance to the department's regional officers when assessing applications to take groundwater from the CAB.

5.2 Specific principles for licensing in the Carnarvon Artesian Basin

The following principles are specific to licensing in the CAB:

- (1) The Birdrong groundwater resource of the CAB receives minimal recharge. The primary aim of this management plan is to manage the impacts of abstraction in the CAB, one being the decline in artesian head levels.
- (2) A groundwater flow model will be used to assist the department's initial assessment of new applications. The model will help predict possible impacts on artesian heads at existing bore sites, and provide guidance on the level of assessment and supporting information required as part of a licence application.
- (3) All new developments must demonstrate the use and consideration of water conservation and efficiency measures to the department's satisfaction as part of their proposals.
- (4) Water use must be consistent with the planning and land use objectives of the region and generate outputs that contribute to sustainable development.
- (5) Applicants requesting a water entitlement greater than 50,000 kL/year or where the impacts of taking water are deemed significant, must provide a monitoring program (operating strategy) (see Section 5.5).
- (6) Should an existing water user allege impacts caused by another user, and available monitoring information provided by the complainant in Section 5.5 does not demonstrate this, the complainant will be required to provide other monitoring data and analyses of the information.

- (7) The department will accept some reduction in the artesian head levels when new users are licensed. However, the reduction in head must not cause unacceptable impacts on existing users' operations (such as ability for artesian pressure move water through efficient distribute systems) without a negotiated and agreed operating strategy between the licensed users and the department.
- (8) Community consultation and involvement in major decisions on groundwater matters will continue as National Water Initiative (NWI) is implemented. This consultation will be managed through the department's Mid-West Gascoyne regional office.
- (9) Allocation limits will be increased to allow development (maintaining a use of 70 per cent of the allocation limit) until the department determines that further allocations of water will impact on existing users' access to water.
- (10) All water will be licensed in accordance with the requirements of the *Rights in Water and Irrigation Act 1914* (RIWI Act) and this plan until review under new legislation.
- (11) Water will be provided to ensure future drinking water supply needs before new commercial licences are issued.
- (12) The principles of the NWI and state water plan will be recognised in water management decisions.

5.3 Licensing approach for the Carnarvon Artesian Basin

Basis for allocation

In Western Australia, water allocation is currently carried out on a first-in-first-served basis. However, during licence application procedures, some applicants may be requested to provide additional information before the application can progress through the approval assessment process.

Licences

Under the RIWI Act, the department issues licences to manage and regulate the use of groundwater. This ensures it is used in a way that minimises impacts on the environment and other nearby groundwater users.

As mentioned in Section 1.5, the RIWI Act requires compulsory licensing of all artesian wells throughout Western Australia. Due to the management requirements of the CAB, all bores abstracting from a regionally confined aquifer in the CAB, whether flowing to the surface or not, including abstraction for stock and domestic purposes, are required to be licensed by the department. This is to ensure all use may be accounted for, which will help assessment and management of the water resource. Failure to comply with these requirements of the RIWI Act may lead to a daily penalty of \$1,000 with a maximum fine of \$10,000.

There are two kinds of licences that are required to take groundwater from the CAB:

- Licence to Construct or Alter a Well (26D licence) - issued under Section 26D of the RIWI Act and required before an existing bore is altered or a new bore constructed in the CAB. The minimum construction requirements under the RIWI Act must be followed.

- Licence to Take Groundwater (5C licence) - issued under Section 5C of the RIWI Act and required before any artesian groundwater can be abstracted from the CAB. A 5C licence includes conditions that reflect the management responsibilities specific to the licensee.

5.4 Applying for a licence

The CAB is situated within the proclaimed Gascoyne and Pilbara Groundwater Areas (see Figure 1.1 in Section 1) and use of CAB groundwater is subject to licensing. Groundwater licences will be issued when the department's assessment process (detail dependent on significance of application) has been satisfied according to Schedule 1 clause 7(2) of the RIWI Act. Assessment must also indicate that the taking of water is consistent with the policies in this plan (see Table 5.1).

Table 5.1 How to obtain a groundwater licence

When do you need a licence?	You will need a licence if you want to take water: <ul style="list-style-type: none"> • for any purpose from the Birdrong (or any artesian or regionally confined aquifer) • within a proclaimed area
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When licence/s do you need?	<ul style="list-style-type: none"> • 26D Licence - Licence to construct/alter a well • 5C Licence - Licence to take water (only after necessary infrastructure to take water is in place)
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It is recommended that you discuss your proposal with the Carnarvon office to ensure water is available for your project

Where do you find an application?	<ul style="list-style-type: none"> • Contact the department's Carnarvon office, or • Download an application form, available at www.water.wa.gov.au
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Complete application form

Assessment of application	The department will use a groundwater model of the CAB to assess likely impacts of the application. The model results will determine the level of assessment required by the licensee, which may include input from a groundwater professional. Other determining factors include the quantity of water required, how much water is available, and the potential environmental impacts of the application.
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The department will decide whether a licence will be granted or refused

Issue of licence	When the licence is received, it is recommended that you <ul style="list-style-type: none"> • read your new licence • check the terms, conditions, restrictions and duration • keep it in a safe place as your licence is a legal document
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It is your responsibility to renew your licence before it expires

A licensed allocation is not a guarantee that the quantity (and quality) of water will always be available to the licensee. In some circumstances, factors outside the department and water users' control may lead to changes in the quality or quantity of the available resource. If any prolonged and unacceptable changes occur, the department will work with users to determine the best approach for managing the situation.

To obtain a licence to construct or alter an artesian bore (26D licence), or to take water from a new or existing bore, the relevant form/s should be completed and returned to the department's Carnarvon district office. For example, this would apply to someone purchasing an established property who wished to have access to water (5C licence). A 26D licence does not allow the licensee to 'take' water, but may be used for groundwater exploration. A 5C licence allows the licensee to take groundwater for the usage and volume specified on their licence. The maximum issue length of new licences or renewals will be until 2012 (until end of this plan or the plan review). A person may apply for a 26D licence and 5C licence simultaneously.

To obtain an application form for a groundwater licence, contact the Department of Water Carnarvon District office or alternatively go to the department's website www.water.wa.gov.au and click on Licences and industry support - Licensing - Forms.

Licence fees

As of 1 July 2007, water administration fees apply to water licences greater than 1,500 kL per year. Application fees apply to new licence applications; applications to amend, trade or transfer existing licences; and applications for new bore construction licences or permits to interfere with bed and banks. There are also annual and other fees. The water licence administration fees are split into seven classes, which were calculated according to the time it takes to administer a water licence. Further information and the fee schedule are available on the department's website (www.water.wa.gov.au) by clicking on Licences and industry support - Licensing-Fees.

Assessment

On receipt of a proposal or application to take water from the CAB (new applications, transfers, agreements or variations of licences), the department will initially determine the risk of the proposal to nearby bores. The risk will be determined by using the CAB groundwater model and internal hydrogeological expertise. This will include an assessment impact on future drinking supplies water for regional towns and communities.

If this assessment predicts that the proposal is likely to impact upon existing users or future drinking water supplies:

- The proponent must provide information that indicates their proposal will not unacceptably impact on the artesian pressure required by existing users to distribute water via their efficient stock watering or irrigation systems. The level of information required from the proponent will be established by the department according to the department's State-wide Policy No 19.
- The applicant must develop a mitigation strategy (such as a private contractual agreement with existing users) to be approved by the department. Negotiating parties should be aware that their agreement does not bind the department, who

may reduce or cancel entitlements if the abstraction or use of groundwater has an unacceptable impact on the resource or other users.

Note: The department will only seek to ensure that artesian head levels are maintained to the degree necessary to support an efficient distribution system from a controlled bore. As one of the department's objectives is to promote the orderly and efficient use of water resources, wasteful use of water will not be supported.

Future public drinking water supply

The department recognises the value of town drinking water supply and will ensure that towns within the CAB have a secure future water supply. The forecast drinking water demands for these towns will be included in the CAB groundwater model. This ensures that the potential water supply for these towns is not affected when new licences are assessed. However, this means that licence applications that impact on, or would be taking water available for future public water supply, will not be granted.

Water efficiency and conservation

Groundwater is an essential requirement and a valuable resource for many developments. Licensees must use groundwater efficiently and ensure that all practical water conservation methods are being considered. Those projects planning to use volumes greater than 50,000 kL/year of groundwater will be required to demonstrate that water conservation methods have been considered and will be implemented where possible to the department's satisfaction.

Some water distribution systems on pastoral stations still contain open bore drains. The department recognises this practice is not water efficient and that phasing out of open bore drains must occur after the current rehabilitation. The department requires all open bore drains to be replaced by more water efficient systems within five years of this plan being released.

Evidence of above mentioned conservation methods for water use will also be required for renewing existing licences.

Environment

There are considered to be no groundwater-dependent ecosystems associated with the CAB, other than wetlands that have formed from uncontrolled artesian flows. These artificial wetlands will not be considered by the department to have environmental values for the purposes of protection. However, groundwater abstraction must still take into account environmental considerations, such as reduction of aquifer head levels, impacts of water use on soil quality, and other land impacts and government regulations. Greater water use efficiency will improve local environments through reducing land degradation caused by uncontrolled flows (such as soil erosion, expansion of feral weeds and animals, etc).

If any naturally occurring wetlands are identified, then an assessment will be made of their value and future licensing decisions will reflect the need to protect these areas.

Development plan

A detailed development plan and timetable stipulating the proposed activity, the area of development and the timeframe for each stage of development must accompany all new or amended licence applications. The department may approve entitlements for staged development of a project, should the total allocation requested be available. The entitlement may gradually be increased to satisfy water needs in accordance with the agreed development timetable.

If the proposed development does not take place or is delayed, the licensee will have to justify why the entitlement should be renewed for the following years or stages. In the event that less water is required for the development than originally anticipated, or there is adverse impact on other users or the environment, the entitlement may be reduced.

Note: If a licence application on a pastoral lease is for purposes other than stock watering or domestic use, then a diversification permit from the Pastoral Lands Board (Department of Planning and Infrastructure) is required.

Hydrogeological assessment

Further hydrogeological assessments including monitoring may be required to assess the possible impacts of abstraction on the resource and other groundwater users. Applicants requiring significant quantities of groundwater may need to provide the department with additional information. This information will be provided in accordance with the State-wide Policy No 19 (available on the department's website).

The level of assessment will depend on the quantity of water sought, the potential risk to other users and department modelling results.

Pastoral non-intensive stock and domestic licence holders will generally not be required to undertake this reporting unless the department considers there is a high risk of impact on other users. All pastoral diversification or intensive livestock water use will be subject to this assessment.

In the cases of more than 500,000 kL/year, an exploratory groundwater licence may be issued, allowing the applicant to investigate the groundwater resources and to determine how the requirement will be achieved without unacceptable impact on other users. At the conclusion of the investigation, a hydrogeological report must be submitted to the department for assessment. The report is to be prepared by a groundwater professional and is to be completed at the applicant's expense.

Operating strategy

Applicants requesting volumes of water more than 50,000 kL/year, if H2 or H3 assessments are required under State-wide Policy No 19, or where the impacts of taking water are otherwise deemed significant, may be required to prepare an operating strategy to the department's satisfaction. Operating strategies must be formally signed and indicate the licensee's responsibilities of managing the impacts of taking and using the water and specify measurable and auditable targets in the following:

- the licensee's land use, water abstraction regime, and the methods and infrastructure used to abstract, treat or distribute water

- water efficiency measures used
- management of nutrient loading (e.g. Nutrient and Irrigation Management Plan)
- methods used to manage impacts on the environment and other water users
- monitoring and reporting requirements
- contingency plans, describing how the licensee will alter their operations to cope with any direction to temporarily reduce water consumption.

All such licences will include a condition requiring licensees to comply with operating strategies that have been pre-approved by the department. If the department is not satisfied with the operating strategy presented by the proponent, the proponent will be required to review appropriately.

Licence conditions and compliance

To manage and regulate groundwater use in Western Australia, licences to construct or alter a well (26D licence) and to take water (5C licence) contain licence conditions, which can be enforced by the department. Licence conditions set out the activities and requirements that must be undertaken by the licensee under the agreement that is formed by a groundwater licence. This ensures that abstraction and use of water is efficient, purposeful and monitored so that the department can manage the resource appropriately. Licence conditions are applied on a case-by-case basis depending on the total volume of groundwater abstraction, groundwater usage and the location of groundwater abstraction. Conditions likely to be part of a licence are described in Appendix A.

Non-compliance with all licence conditions (including monitoring and reporting) may result in the review and amendment or revocation of a licence.

Applications (or renewals) likely to be refused

Applications must be refused if the department considers that an applicant would not be willing or able to comply with the terms, conditions and restrictions included in a licence. The department may refuse a licence if it is not satisfied that the applicant has the financial or other resources to carry out the activity, or if a person has been convicted of an offence under the RIWI Act.

The main objective of managing the Birdrong (CAB) is to manage the impacts of use on artesian pressure. Therefore, applications for usage that will cause inefficient use and wastage of water will not be approved by the department. For example, the department considers power generation an acceptable by-product of groundwater abstraction for another usage (such as aquaculture). Applications to use artesian water for power generation, with no associated productive use will not be supported by the department. This activity would be deemed an inefficient and low-value use of groundwater.

Applicants likely to be refused under this plan's licensing policy should be invited to meet with the department's officers to discuss the grounds for the likely refusal. Other possible water source options (if any) would also be discussed at this meeting.

Appeals relating to licences to take water

Applicants aggrieved by a decision of the department may apply to the State Administrative Tribunal (SAT) for a review of the decision (Section 26GG of the RIWI Act). The SAT reviews decisions relating to a refusal of a licence, the period for which a licence is granted or any condition or restriction on a licence.

Minimum bore construction standards and requirements

Applicants must hold a 26D licence from the department before beginning any drilling for the production, monitoring or investigation of groundwater. Once drilling is finished, applicants must complete and submit a 'particulars of completed borehole' form. This form can be obtained by following the same process as in Section 5.4 - Applying for a licence. Failure to supply this information on drilling in the proper form will prevent a 5C licence to take water from being approved.

All bores to be drilled into the CAB to take 500,000 kL/year or more will require a geophysical log. This log must be taken from an exploratory bore and provided to the department (by fax or email is sufficient). The department will subsequently advise the driller where to screen before drilling of the production bore begins. A single 26D licence will cover both exploratory and production bore (if approved). The department should supply the screening depth within 24 hours of the geophysical log being supplied.

Drilling must be completed by a contractor certified with the Australian Drilling Industry Association. The driller must be certified to Class 3 standard permitting drilling operations in flowing (artesian) aquifer systems. Authorised department staff will randomly supervise the drilling of new bores. For all bores drilled into the Birdrong (or any artesian aquifer) a minimum construction standard of pressure cement grouting is required. Applicants and drillers must contact the department's Mid-West Gascoyne Regional office to confirm requirements for drilling into any regionally confined aquifer.

Other information required for drilling is provided in *State-wide Policy No 19 - Hydrogeological reporting associated with a Groundwater Well Licence* and should be reviewed before drilling to ensure compliance.

5.5 Water use management requirements

Water resource management committee and advisory committee

In accordance with Division 3C Section 26GK of the RIWI Act, the department may establish a local water resource management committee or other appropriate advisory committee, to assist water resource planning and management. While there is currently no committee for general licensing or management advice in the Gascoyne Groundwater Area, the department has established an advisory group to progress the Carnarvon Artesian Basin Rehabilitation Project. The Carnarvon Artesian Basin Rehabilitation Group consists of three pastoralists, one resource user (mining, horticulture or tourism), one community representative and an officer each from the Department of Water and the Department of Agriculture and Food.

Monitoring and metering program

The licensee will establish a groundwater monitoring regime, to monitor the impacts of their abstraction on groundwater levels. This monitoring regime will be established as part of the application process and to the department's satisfaction. Monitoring requirements will not necessarily be restricted to the development area associated with a licence. The department may also request off-site monitoring of impacts if large volumes of groundwater are abstracted. This information is used to ensure protection of neighbouring groundwater users, minimise resource degradation and maintain the long-term sustainability of the aquifer system. It is expected that all uncontrolled bores will progressively be decommissioned or rehabilitated.

All groundwater licences require department approved flow meters and the ability to measure static artesian head levels (i.e. attach pressure gauge) on each bore. All licensees will be required to submit the following information to the department within two months of the end of each water accounting year:

- volume of groundwater abstracted from each bore at the end of every three-month period
- artesian pressure readings from each bore at the end of every three-month period
- salinity of bore water
- type of activity of water use
- area of activity of water use.

The department will use this information together with the water level and quality information to help manage the regional impact of groundwater abstraction and update the CAB Groundwater Model.

The department has recently developed a meter installation guide, following the requirements under the Rights in Water and Irrigation (Approved Meters) Order 2003. The guide outlines how to install meters and the standards required for Western Australian water meters. All new meters installed on artesian bores within the CAB must comply with the requirements of the RIWI Act (Approved Meters) Order 2003 (see Appendix B).

An Australian metering standard is currently being developed as part of the NWI. The new standard will be consistent with Western Australia's current metering requirements and is being coordinated by a metering expert group with assistance from the department.

It is important to note that a licensee may be required to re-calibrate water meters if results are not considered to be accurate.

Water use surveys

Officers of the department will carry out appropriate water use surveys to determine if the licensee is using their allocation according to their licence conditions. If a licensee is not using all their authorised allocation, they will be required to justify why their allocation should not be reduced at the time of licence renewal to better reflect current and future use requirements.

The department may reduce unused portions of licensed allocations in accordance with *State-wide Policy No 11 - Management of unused licensed water entitlements (2003)*. The department considers that an unused water entitlement is 'that part or all of the licensed annual water entitlement that has not been taken (used) for more than three consecutive years, unless otherwise specified in licence conditions or operating strategies or agreed development timeframes' (page 3, WRC 2003).

The department will reduce entitlements where it cannot be established that extenuating circumstances have resulted in part of the entitlement not being used. Reduction of unused allocations will be strictly adhered to, to ensure ecologically sustainable development.

Licensees using water in excess of that approved will be subject to appropriate action by the department. This action will limit any additional risk to the groundwater resource, its dependent values and other groundwater users. Site inspections and water use surveys should be undertaken periodically to assess compliance of in-situ development with licensed activities. Action should be taken to address overuse and non-compliance with the terms and conditions of the licence on a case-by-case basis, depending on the circumstances.

Re-allocation of entitlements

Where existing entitlements remain unused or the applicant proposes to reduce their allocation, then the water may be recouped by the department. Recouped water may become available for re-allocation.

Renewal of existing licences

Groundwater licences to take water are valuable documents that should be kept in a safe place and not allowed to expire.

It is the licence holder's responsibility to make an application to extend the term of the existing licence before the expiry date. The department will endeavour to notify licence holders in advance that their licences will soon expire.

Generally, when a licence to take water is due to expire, and the licensee has abided by all the licence conditions, the licence will normally be extended for a further period. If an application for a licence to take water expires, however, and the licensee has not abided by all the licence conditions, there is no guarantee that the term of the licence will be automatically extended. The licensee will need to show cause why the term of the licence in its entirety should be extended or the licensee may need to apply for a new licence. If a licensee has not abided by all the licence conditions, the licence is unlikely to be extended without demonstration of extenuating circumstances.

In order to renew or amend a groundwater licence, the licence holder should complete the relevant form and submit it to the Carnarvon Regional office before the current licence expires. The form to amend or renew a licence can be obtained by following the same process in Section 5.4 - Applying for a licence.

5.6 Trading water entitlements

Once the department identifies that there is no further water available from the resource, proponents will have the opportunity to purchase their water entitlement from an existing user through trading. The ability to trade water entitlements is provided by Schedule 1, Division 7 of the RIWI Act and the relevant procedures or policies are detailed in *State-wide Policy No 6 - Transferable (Tradeable) Water Entitlements in WA, 2001*.

Trading water entitlements involves a licence holder (vendor) trading all or part of their licensed entitlement to another water user (purchaser). A purchaser who does not already have a licence must undergo the normal licence assessment process and receive a new licence as part of the trade. Where the purchaser already has a licence, the assessment will be on the outcomes of the trade, usually an increase in abstraction, and whether these are acceptable.

Entitlements can be traded temporarily or permanently and must take place within the same water management subarea. Temporary trades are a form of lease made through a temporary agreement and assignment of part or all of a licensed entitlement to another party. This second party is then able to operate under the licence for the period of the agreement. Where trading is permanent, the vendor's original licence will be amended to reflect the trade or cancelled altogether if the full entitlement has been traded. A new licence will be issued to the purchaser or their existing licence amended to reflect the trade.

Licences for non-intensive (pastoral) stock and domestic purposes may not be traded.

5.7 Annual reporting for licensees

Within two months of the end of each water accounting year, licensees are required to submit a monitoring report to the department. Reports are to be prepared according to department guidelines (available from regional offices).

- For groundwater management planning and annual reporting, the water accounting year in the Gascoyne Region begins on 1 January and ceases on 31 December. All management decisions and monitoring practices undertaken by the department will be based on this accounting period.
- Monitoring and regular reporting by licensees should ensure that any emerging issues are quickly identified and dealt with during the first review of this plan (any issues should be sent to the Carnarvon Regional office). Monitoring will be carried out with respect to the conditions applied to a licence.
- The monitoring report will be used to provide the department with information on the status of the groundwater resources in terms of quantity and quality. The information will include all observations to the end of the water accounting year, and identify any emerging issues relevant to access and use of the groundwater resources in the CAB. The information will also be used to update and calibrate the CAB Groundwater Model.
- Receipt of the report will be acknowledged in writing and the licensee contacted if any clarification is required.
- Large licences may have separate monitoring requirements established in their licence or through an attached operating strategy.

5.8 Annual reporting for the department

The department will prepare a report with details on the:

- metered annual groundwater abstraction compared with licensed entitlements
- effectiveness of the management strategies in meeting the purpose and objectives of this plan
- results of the monitoring program.

6 Implementation and review

The Department of Water has the statutory responsibility of administering and enforcing this plan. The provisions in this plan for the allocation and taking of groundwater from the Carnarvon Artesian Basin (CAB) will continue to have effect under the existing terms and conditions in this plan, until it is reviewed or replaced by another plan.

6.1 Implementation of this plan

The implementation program will set out the means by which the recommendations of this plan will be achieved.

If implementation of the plan raises issues of concern that need to be addressed urgently, an amendment of this plan may occur at any time if the department is satisfied that the plan's objectives are:

- no longer appropriate
- are not being met.

Actions

Table 6.1, below, summarises the actions identified throughout this plan. These actions are to be delivered within the timeline identified. The actions are either set by a defined date, or will be implemented if certain triggers are reached, such as a percentage of the allocation limit being reached. They are ordered by likely timeline of implementation.

Table 6.1 Actions for plan implementation

Responsibility	Action	Trigger or timeline
Department of Water	Use logs and data from new or recommissioned bores, or information from the Carnarvon Artesian Basin Rehabilitation Project, to update the department's WIN database. This database will provide improved information as to the status of the Birdrong Aquifer.	Ongoing.
Department of Water (Mid-West Gascoyne regional office)	A review of bore logs (where available), as it is now known that some bores in the southern areas of the CAB are drawing water from the Windalia Radiolarite/Sand Aquifer or the Kopke Sandstone.	Within one year of the plan.

Responsibility	Action	Trigger or timeline
Department of Water	Consider whether unproclaimed areas within the CAB (Figure 1.1) need to be considered for proclamation. Pressure on the resource and priorities of other proclamation projects will determine if and when proclamation of these areas will occur.	Within one year of the plan.
Department of Water (Head office and Mid-West Gascoyne regional office)	Define a monitoring program to ensure appropriate monitoring of regional Birdrong water levels, head pressures, water quality and licence compliance are carried out.	Within two years of the plan.
Department of Water	An assessment of unlicensed water use.	Within two years of the plan.
Department of Water	License all relevant use	Within three years of the plan.
Department of Water	Engage users in program of awareness of trading concepts.	When modelling and monitoring shows the aquifer is becoming fully allocated.
Department of Water	A formal water use survey and follow-up compliance program will be carried out before the review of this plan to confirm changes in use of water and ensure accurate accounting and licensing of water for future planning.	When modelling and monitoring shows the aquifer is becoming fully allocated.
Department of Water	Review allocation plan.	In five years, if requested to by the minister, or update is needed through changes in legislation.

CAB=Carnarvon Artesian Basin; WIN=Water Information Network

Evaluation

This plan will be evaluated through public status reporting to ensure that it is successful and achieves its positive water resources outcomes. This section describes how the evaluation will be carried out.

A status report will be released by the department the year after publication, and then every two years. This report will identify all actions required by the plan that have been completed or are pending and will track progress against objectives (see Section 4.2). This will be advertised in the local paper and made available through the department's website.

If objectives are not being reached and other situations such as impacts are occurring despite allocation limits not being reached, this report may recommend the review of the plan.

6.2 Review of this plan

- This plan will be reviewed, or replaced within five years. The department, in consultation with the community, will consider what action needs to be taken in respect of this plan after taking into account any information gathered from the monitoring program or relevant reports.
- The purpose of the review is to decide whether the plan's provisions remain adequate and appropriate for the sustainable management of the groundwater resources in the CAB.
- The minister may direct that this plan be reviewed earlier than five years due to changes that require changes to the rule and policies of this plan.
- The review may recommend the continuation of this plan, or the development of an amended plan.
- Corrections for clerical mistakes, errors, inaccuracies or omissions, or the replacement of any outdated factual information may be made at any time and will be publicly declared.
- Western Australia is currently updating and reviewing legislation for the water resources of the state. Any significant changes in legislation that may affect this plan will need to be noted and the appropriate changes made.

Appendix 1

Carnarvon Artesian Basin resource fact sheet

This fact sheet provides information on the Carnarvon Artesian Basin (CAB) and is intended to help licence assessment.

Subarea Information	
Area	Referred to as the Carnarvon Artesian Basin (CAB). Situated mostly within the Zuytdorp/Ningaloo subarea (Gascoyne Groundwater Area) but extends into the Ashburton subarea (Pilbara Groundwater Area). See Figure 1.1.
Comments	Groundwater is an important resource for pastoralists who rely on artesian pressure to move water through stock watering and irrigation systems. A groundwater model to determine the draw-down impacts on nearby users will be used to assess new applications (including increase of existing licence entitlements). Applications to take groundwater from the Windalia, Birdrong, Nannyarra, Kopke and Tumblagooda formations will be assigned to the Birdrong Groundwater Resource.

Hydrogeology	
Carnarvon Artesian Basin	Includes six main formations (from shallowest to deepest): Windalia Radiolarite, Windalia Sand Member, Nannyarra, Birdrong, Kopke and Tumblagooda Sandstones. The Birdrong Sandstone is the main aquifer in the CAB.
Birdrong	The aquifer varies in thickness but is usually between 20–30 m thick, and also varies in depth from <200 m near Hamelin Pool to >500 m at Carnarvon. Salinity increases east to west (towards the coast), which varies over the CAB from fresh to highly saline (up to 14,000 mg/L total dissolved salts). The Aquifer outcrops along the eastern margin of the Zuytdorp/ Ningaloo subarea and shares a hydraulic connection to underlying formations (Kopke and Tumblagooda).

Groundwater Resources ^a	
Aquifer	Birdrong Sandstone (including Windalia, Nannyarra, Kopke and Tumblagooda formations).
General water quality	Variable depending on location and aquifer (2,000–>12,000 mg/L total dissolved salts).

Groundwater Resources^a	
Allocation limit (currently)	30,000,000 kL/year.
Licensed allocations	7,429,560 kL/year.
Available supply ^b	22,570,440 kL/year.
Licensed entitlements as % of current allocation limit	25%. Does not include additional requested allocations currently being assessed by the department.
Resource classification	As the new allocation limits for the Birdrong will be flexible, the resource will not exceed the C3 allocation category level (71–100% allocated).
Comments	All applications will be assessed by their impact on artesian pressure and will not need to be within the allocation limit. The allocation limit is considered to be flexible and may need to be increased before a new licence is issued that would exceed the allocation limit. Contact DWAID (Divertible Water Availability Inventory Database) custodian for more information.

a Information relates to the Birdrong in the Gascoyne Groundwater Area only, figures as at 23 November 2006

b Available supply=allocation limit minus licensed allocations (does not account for applications currently being assessed by the department)

Groundwater Use	
Current use	Abstraction (as at 2 March 2006) is mainly used for mining (48%) and pastoral stations (27%). Other licensed allocations are for public services (11%), commercial use (10%) and public water supply (4%). Actual use is unknown, but the estimate of uncontrolled flow is 4.4 GL/year.
Potential future use	Increase in public water supply allocations (as town population increases), mining development explorations continuing), proposed horticultural precincts (e.g. Meedo Station) and agricultural diversification on pastoral stations.
Constraints	The management objective for the CAB is to maintain the required artesian head levels at existing bores, which changes with location. New proposals to take groundwater from the CAB will be assessed by the groundwater model to determine the impacts on nearby users.

Licence Assessment	
Other users	<ul style="list-style-type: none"> The CAB Groundwater Model may be used to determine the likely impacts of a proposed development on existing users. Contact the department's Groundwater Assessments Section.
Ecological	<ul style="list-style-type: none"> There are considered to be no natural groundwater-dependent ecosystems within the CAB. Three sites are listed as threatened ecological communities located at Hamelin Pool, Exmouth and within the Ningaloo Marine Park. There are 13 declared rare fauna in the CAB, of which the majority are located in the south of the CAB.
Social, cultural and recreational	<ul style="list-style-type: none"> Local governments associated with CAB in the Gascoyne Region are the Shires of Exmouth, Carnarvon, Upper Gascoyne and Shark Bay. The Gascoyne Development Commission is a Western Australian State Government agency that promotes the region. The majority of the CAB is covered by part of the Natural Heritage Trust Rangelands (WA) area, with the southern most part being part of the Northern Agricultural Region. There are three national parks situated in the Gascoyne Region: Cape Range National Park, Francois Peron National Park and Kennedy Range National Park. There are places of National Heritage in Carnarvon (nine), Exmouth (two) and Ashburton (one).
Pastoral stations	<ul style="list-style-type: none"> Pastoralists will require a diversification permit from the Pastoral Lands Board (Department of Planning and Infrastructure) before a groundwater licence application is assessed by the department for any purposes other than stock watering and domestic use.

Licence conditions for the CAB	
Construction or alteration of wells (26D licence)	O001, O022, O160, A001, A002, A003, A004, A006, A013 (exploratory bores only), A015, A030 (exploratory bores only), C030, C031, C033.
Groundwater licences (5C licence)	A006, A103, M001, M012, M040, M074, M085, M125, M165, M182, S126, S193 (for horticultural use only), R003, R011.
Comments	Other licence conditions will be applied on a case-by-case basis.

General licence conditions and codes	
Code	Condition
O001	That 48 hours prior notice is given to the Water and Rivers Commission ³ of the commencement date for drilling.
O022	Approval by the Water and Rivers Commission ³ is to be obtained prior to the construction of additional and replacement wells and the modification or refurbishment of existing wells.
O160	A licence to take water may not necessarily be issued at the conclusion of the exploratory program authorised by CAW ⁴ (groundwater licence number).
A001	That the casing or casings are equipped with centralisers not less than one per casing length and are inserted in a hole providing an annulus of not less than 30 mm and that the annulus is pressure cement grouted from the top of the screen to the surface.
A002	That the bore is adequately capped and if it flows at the surface, equipped with a valve to control the flow.
A003	That the borehead is fitted with a removable plate directly above the borehole to provide vertical access for logging purposes.
A004	That a 13 mm tapping is provided in the borehead for the purpose of measuring the static head.
A006	That the bore is not permitted to run to waste.
A013	That on completion of the exploratory drilling program, the licensee shall submit a hydrogeological assessment of the groundwater resource, prepared by a groundwater professional.
A015	That should the bore be abandoned it shall be cemented off to the satisfaction of the Water and Rivers Commission ³ within 30 days of being abandoned.
A030	That exploratory bores are capped to the satisfaction of the Water and Rivers Commission ³ .
A103	The supply of water from the bore/s shall be controlled to the satisfaction of the Water and Rivers Commission ³ .
C030	The licensee is required to provide to the Water and Rivers Commission ³ a geophysical log of the bore.
C031	That should the bore/s be abandoned it/they shall be sealed off to the satisfaction of the Water and Rivers Commission ³ .

³ Water and Rivers Commission is still the issuing authority for water licences until the Department of Water is formally legislated.

⁴ CAW is a licence to Construct or Alter a Well (26D licence).

General licence conditions and codes	
C033	The well must be constructed by a driller having a current Class 3 water well driller's certificate issued by the Western Australian branch of the Australian Drillers Industry Association or other certification approved by the Water and Rivers Commission ³ as equivalent.
M001	That the licensee allows officers of the Water and Rivers Commission ³ access to the bores or wells to measure water levels and obtain samples for monitoring purposes.
M012	That the licensee shall install and maintain a cumulative water meter of a type approved by the Water and Rivers Commission ³ .
M040	That the licensee shall allow access, in an agreed manner, by the Water and Rivers Commission ³ personnel for the purposes of inspection at any time.
M074	That the licensee shall record the volume of groundwater drawn monthly and forward the information to the Water and Rivers Commission ³ by 31 December each year.
M085	The Water and Rivers Commission ³ , at its discretion, may direct changes to be made to the monitoring program at any time.
M125	The licensee shall measure the electrical conductivity in millisiemens/metre of the water from each production well every six months and report the results by 31 December each year.
M165	The licensee shall comply with the operating strategy as prepared by the licensee and approved by the Water and Rivers Commission ³ on (date), including any modifications to the strategy as approved during the term of the licence.
M182	The licensee shall measure the static head pressure of the bore/s every three months and report the results to the Water and Rivers Commission ³ by 31 December each year.
S126	<i>Note: This is an existing condition that will no longer be used in the CAB as it promotes inefficient distribution systems.</i>
S193	The licensee shall implement and comply with the Nutrient Irrigation Management Plan (NIMP) as prepared by the licensee and approved by the Water and Rivers Commission ³ on (date), including any modifications to the NIMP as approved during the term of the licence. (for horticultural use)
R003	That should the licensee's draw adversely affect the aquifer or other users in the area, the Water and Rivers Commission ³ may reduce the amount that may be drawn.
R011	That should the drawing of water from the bore adversely affect the aquifer, and/or other users, the Water and Rivers Commission ³ shall direct the licensee to effect necessary action to make good the supply to affected users.

Appendix 2 Relevant sections of the *Rights in Water and Irrigation Act 1914*

Division 3. 26A Artesian wells to be licensed

(1) A person shall not, except pursuant to a licence issued for that purpose under section 26D, commence, construct, enlarge, deepen or alter any artesian well or cause, suffer, or permit any of those things to be done.

(2) A person who -

(a) Being an owner or occupier of land, contravenes or fails to comply with subsection (1); or

(b) Being a person engaged for the purpose of carrying out any work mentioned in subsection (1), commences or carries out any such work that is not authorised by a licence under section 26D.

commits an offence and is liable to a fine not exceeding \$10,000 and a daily penalty of \$1,000.

Schedule 1 Clause 7 (2)

In exercising that discretion the Commission is to have regard to all matters that it considers relevant, including whether the proposed taking and use of water –

(a) are in the public interest;

(b) are ecologically sustainable;

(c) are environmentally acceptable;

(d) may prejudice other current and future needs for water;

(e) would, in the opinion of the Commission, have a detrimental effect on another person;

(f) could be provided for by another source;

(g) are in keeping with -

(i.) local practices;

(ii.) a relevant local by-law;

(iii.) a plan approved under Part III Division 3D Subdivision 2; or

(iv.) relevant previous decisions of the Commission;

or

(h) are consistent with -

(i.) land use planning instruments;

(ii.) the requirements and policies of other government agencies; or

(iii.) any intergovernmental agreement or arrangement.

Division 3Cs. 26GK Establishment of committees

- (1) The Minister may determine that a water resources management committee (a “committee”) is to be established for any locality or area of the State.
- (2) Subject to an order made under subsection (4), a committee may from time to time appoint, discharge or alter, subcommittees of members of the committee, or members and other persons, as it thinks fit to advise it on any matter within the functions of the committee, particularly a matter of localised interest.
- (3) A subcommittee is to be presided over by a member of the committee and sections 26GL(3), 26GN, 26GO, 26GR and 26GS apply in respect of a subcommittee as if reference in those sections to “committee” were a reference to “subcommittee”.
- (4) Where subsection (1) applies, the Minister must, subject to section 26GL, by order prescribe -
 - (a) the locality or area for which the committee is established;
 - (b) the name of the committee;
 - (c) the manner in which the committee is to be appointed; and
 - (d) any other provisions the Minister thinks fit relating to subcommittees or the committee’s membership, constitution and procedures, including providing that the terms of members’ appointments are to vary, so that the terms of all members do not expire simultaneously.
- (5) The Minister may at any time by further order amend or revoke an order made under this section.
- (6) An order made under this section is to be published in the Gazette for public information.

The Rights in Water and Irrigation (Approved Meters) Order 2003

Made by the Water and Rivers Commission under clause 46 of Schedule 1.

1. Citation

This order may be cited as the *Rights in Water and Irrigation (Approved Meters) Order 2003*.

2. Approved meters

A meter is approved for the purposes of clause 46 of Schedule 1 to the Act if the meter -

- (a) complies with Australian Standard AS 3565 or AS 3778, or
- (b) has been calibrated by a National Association of Testing Authorities accredited laboratory and the results reported on a National Association of Testing Authorities report or certificate.

This order is available from the State Law Publisher (14 November 2003/179 in the Government Gazette database at: www.slp.wa.gov.au).

Glossary

Abstraction	Pumping groundwater from an aquifer.
Allocation limit (AL)	Estimated maximum level of allocation (including Public Water Supply Reserves and approved reserves) that can be abstracted during a water accounting year, which allows acceptable levels of pumping stress, and protects dependent economic, social, cultural and environmental values. Allocation limits are set for each water resource (aquifer) within a subarea and may be amended over time to reflect significant monitoring outcomes and sustainability determinations.
Aquifer	A geological formation or group of formations that is able to receive, store and transmit significant quantities of groundwater.
Artesian aquifer	A confined aquifer with sufficient pressure to cause water to rise in a bore above the top of the aquifer. If water rises above the ground surface it is termed a 'flowing artesian' aquifer.
Artesian bore/well	The Rights in Water and Irrigation Act 1914 defines an artesian well as 'a well, including all associated works, from which water flows, or has flowed, naturally to the surface' (Part I, s.2).
Confined aquifer	An aquifer that is confined between aquitards and containing water under pressure.
Entitlement	The quantity of groundwater permitted to be abstracted by a well licence, usually specified in kilolitres/year (kL/year).
Evaporation	The vaporisation of water from a free-water surface above or below ground level, normally measured in millimetres.
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.
Groundwater	Any underground water, including water that percolates from the ground surface into a well or other works.
Groundwater area	An area of land that overlies a particular water resource, or resources, that has been proclaimed under section 26B of the Rights in Water and Irrigation Act 1914, for the purposes of controlling through licensing, the construction of water wells and the taking and use of the water resource(s).
Groundwater availability	The annual amount of groundwater available for abstraction, equal to the allocation limit minus any licensed and unlicensed use.
Groundwater-dependent ecosystem	An ecosystem that is partially or fully dependent on groundwater for its sustained existence.

Hectare (ha)	10,000 square metres or 2.47 acres.
Kilolitre (kL)	1,000 litres, 1 cubic metre or 220 gallons.
Leakage	The flow of water from one aquifer to another.
Licence	'A 5C licence is a right that allows the licence holder to "take" water from a watercourse, wetland or underground source. Under the provisions of s.5C, unless a person holds a licence, any unauthorised taking of water is prohibited except where a person has another right to do so (i.e. "riparian right").' (WRL Handbook)
Policy	Refers to a guideline that is not directly supported by any legislation but has been adopted by the Water and Rivers Commission as its guideline.
Potentiometric level	An imaginary surface representing the total head of groundwater and defined by the level (surface) to which water will rise in a well.
Public water supply reserve	A volume of groundwater that has been reserved for town water supply purposes (drinking water for human consumption) and, where appropriate, to satisfy the water requirements for developments of state significance under State Agreements to which the <i>Government Agreements Act 1979</i> applies.
Recharge	The downward movement of water, usually expressed as a percentage of rainfall depending on the stratigraphy, that contributes to the groundwater resources of an aquifer system.
Regionally confined aquifer	An aquifer that is confined and/or artesian at any point within the plan area.
Salinity	The measure of total soluble salt (i.e. mineral constituents in water). Water resources are classified on the basis of salinity in terms of total dissolved salts (TDS) or total soluble salts (TSS). Measurements are usually in milligrams per litre (mg/L) or parts per thousand (ppt).
Surface water	An open body of water, such as a stream, lake, or reservoir.
Sustainability	Meeting the needs of current and future generations through integration of environmental protection, social advancement and economic prosperity.
Sustainable groundwater yield	The groundwater extraction regime, measured over a specified planning timeframe that allows acceptable levels of stress and protects dependent economic, social, and environmental values (Department of Environment and Heritage 2004).

Subarea	A subdivision of a proclaimed groundwater area on the basis of hydrogeological and land use boundaries, for the purpose of closer management of the water resource(s).
Transferable (tradeable) water entitlement	The ability to transfer or trade a water entitlement, or a part thereof, to another person within a common water resource.
Unconfined aquifer	An aquifer that has its upper boundary at the earth's surface.
Water conservation	The management of water use to achieve and maintain an appropriate level of water use efficiency.
Water efficiency	The minimisation of water use through adoption of best management practices.
Water entitlement	The quantity of water that a person is entitled to take on an annual basis in accordance with the RIWI Act or a licence.
Water resource	A watercourse, wetland or underground water source to which section 5C of the RIWI Act applies.
Water regime	A description of the variation of flow rate in surface water or water level in groundwater over time; it may also include a description of water quality.
Watertable	The groundwater surface of an unconfined aquifer at which pressure is equal to atmospheric pressure.
Well	A hole dug or drilled into an aquifer to monitor or abstract groundwater.
Wetland	A permanent or seasonal lake, swamp or permanently waterlogged soils or inundated land.

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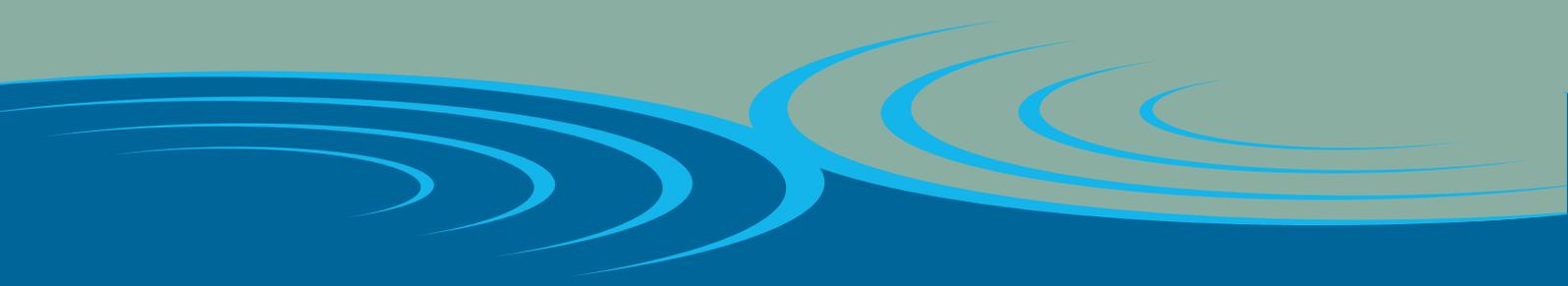
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