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

South West
Regional water plan 2010–2030

Supporting Detail

Looking after all our water needs

May 2010

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Department of Water

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Professional advice should be obtained before applying the information contained in this document to particular circumstances.

Contents

Appendices

Figures

Tables

1 Introduction

The *South West regional water plan* (the Plan) refers to the South West region[1] as shown in Figure 1.

Figure 1 *The* South West regional water plan *area*

[1] In referring to the 'South West region' as applied to this Plan, capitals will be used for 'South West'. However, small letters will be used when referring to the 'south west' to avoid confusion in other documents that describe the South West of Western Australia as the area from Geraldton to Albany.

The South West regional water plan consists of two documents:

1 *Strategic directions and actions* – outlining the south west's major challenges in water resource management

2 *Supporting detail* (this document) – providing the background, technical and non-technical information on the region's water resources, giving a deeper understanding of the issues and proposed solutions.

1.1 Background information

The Department of Water prepared three background documents (DoW 2007a–c) to ensure broad consultation during the Plan's preparation:

a *South West water resources – a regional overview*

b *South West water resources – a water policy overview*

c *South West water resources – a review of future trends.*

After the draft Plan was released in June 2008 for public comment, the department received 26 submissions from a range of interest groups (see the accompanying *Statement of response* document for details).

These documents are available on the Department of Water's website at <www.water.wa.gov.au/regionalplanning>.

1.2 The Plan's community consultation process

In March 2007 the Department of Water released *Designing a sustainable water future* (DoW 2007d) to inform the community about the Plan's development. The document invited members of the south west community and interested groups to discuss the region's water issues.

With the help of the South West Aboriginal Land and Sea Council, in May 2007, the department held three workshops in Bunbury, Busselton and Narrogin at which Aboriginal people gave input to the Plan (Brad Goode & Associates 2007).

In November 2007, the department convened the South West water forum, which brought together representatives from industry, agriculture, horticulture, public water supply, local government and recreation, as well as Indigenous, environmental and other interests in water management, to inform the Plan's development. (Appendix A provides a list of invited groups.)

In addition, the department held discussions with key water sector representatives including delegates from local government, land development, agriculture, minerals and energy, water service provision, plantation forestry and natural resource management. The consultation process identified the regional water management issues described in Section 3.2 of the Plan's *Strategic directions and actions* document.

1.3 Roles and responsibilities

The sustainable management of the state's water resources is the responsibility of the Minister for Water with the support of the Department of Water.

The Department of Water was established in 2005 and is responsible for water resource policy, planning and management, water services policy and the overall management and regulation of water resources in Western Australia. It is accountable for investigating and assessing water resources, providing water security for the environment and community uses, licensing water-use, managing catchments, protecting drinking water sources, drainage planning, floodplain management, water services policy and implementing water reform. The department has links with many other state government agencies with an interest in water management in the South West and these are listed in Appendix B.

In addition, many non-government and private-sector organisations contribute to water resource management in the south west. Among them are the catchment groups and peak industry bodies representing a diverse array of interests including the environment, agriculture, horticulture, mining, plantation farming, recreational fishing, tourism, land development, sport and recreation, and aquaculture.

1.4 Water reforms

The South West region is facing the dual challenges of population growth increasing water demand and a drying climate reducing water availability. More than ever before, water reform is needed to ensure the region's water resources are shared equitably among users, water for the environment is clearly recognised, and social and economic values are placed on water.

In 2006 Western Australia signed the *Intergovernmental Agreement on a National Water Initiative* (NWI 2004), thus embarking on a statewide program of water reform.

The NWI is an agreement between the Commonwealth of Australia and all states and territories that recognises the need to increase the productivity and efficiency of Australia's water-use and improve water management across the country. In particular, the NWI seeks to provide more confidence for those investing in the water industry by:

- amending state water legislation to enable full implementation of the water reform measures
- undertaking more sophisticated, transparent, comprehensive and statutory-based water planning that deals with key issues such as water-use efficiency and provision of water to meet specific environmental outcomes
- providing secure water access entitlements
- committing to return over-allocated water systems to environmentally sustainable levels of extraction

- undertaking better monitoring, reporting and water accounting for water-use, and improving public access to information
- removing barriers to trade in water and setting up an open trading market
- clarifying the assignment of risk for future changes to water availability.

The Department of Water has developed *Western Australia's implementation plan for the National Water Initiative* (DoW 2007e). It describes how the national water reform agenda will be applied in Western Australia and sets out the key timeframes for its delivery. The NWI's implementation in this state will be underpinned by water legislation reform.

Water resource management legislation

The state's water legislation will be amended so that the water reform measures may be implemented fully. A new Water Resources Management Bill will provide a contemporary approach to water management, while a new Water Services Bill will consolidate regulatory arrangements for the construction and operation of works associated with water services.

The passage of the new legislation, currently scheduled for 2011–12, will support the water management requirements of the Department of Water. It will enable the development of new statutory water allocation plans, new forms of water access entitlements, increased metering and monitoring of water extraction, regulation of water interception activities (where necessary) and increased opportunities for water trading.

Statutory water allocation planning

Statutory water allocation planning is an important mechanism to help the government and the community make water allocation decisions to meet economic, environmental and social objectives in the South West.

Statutory water allocation planning for the region will provide for:

- secure ecological outcomes and define appropriate management arrangements to achieve those outcomes
- resource security outcomes by determining the rules to allocate water on a fair, equitable and sustainable basis.

The statutory water allocation plans developed for the region's priority areas will be informed by best-available science, socio-economic analysis and community input.

Consumptive pools and water access entitlements

In addition to the continuation of the existing water licensing process, new forms of entitlements – to be known as water access entitlements (WAEs) – will be established under the new legislation. The consumptive use of water for non-domestic use will require a WAE, separate from land, to be issued as a perpetual

share of a specified water resource (known as a consumptive pool), as determined by a relevant statutory water allocation plan.

The intent of a WAE is to enable the Department of Water to allocate water to consumptive use on the basis of water availability. A WAE will not be tied to any parcel of land, but will entitle the holder to a volume of water depending on how much is available from the consumptive pool. Annually or periodically, the department will determine the water available from the consumptive pool and allocate this water to WAE holders, on the basis of their share of the consumptive pool. However, a WAE holder will not be able to extract and use water from a water resource without a water allocation, a 'water take' licence and a 'water use' licence. These components are sometimes referred to as the 'unbundling' of a licence currently issued under the *Rights in Water and Irrigation Act 1914* (WA), which incorporates all these components in the licence.

Under a drying climate, the water available in a consumptive pool may reduce. The department may then need to reduce the water allocations of WAE holders to protect the integrity of environmental values and/or basic rights. The opposite may also occur after a particularly wet year. To put it in simple terms, while the share in the consumptive pool will not change, the volume that this share represents may change.

Consumptive pools and WAEs may not operate everywhere in the south west, but are likely in defined water systems where demand for water is high and significant competition for water exists. Water licences will continue to operate in parts of the region where consumptive pools have not been, or may not be, established.

Addressing over-allocation

Failure to adhere to the sustainable yields and allocation limits of a water resource may result in over-allocation. Over-allocation of water resources can lead to over-use that may produce short-term economic gains but will eventually lead to detrimental environmental impacts. Social and economic impacts can also occur when over-allocated and over-used water systems are subject to allocation reductions to return them to sustainable levels. The department will firstly work towards avoiding over-allocation and secondly, where it does occur, set appropriate pathways to return water resources to sustainable levels of allocation.

The department is also developing a risk-assignment framework that will apply post-2014 to any future reductions in the availability of water for consumptive use. It will apply to water resources subject to statutory water allocation plans incorporating consumptive pools and WAEs. Briefly, WAE holders will bear the risks of any entitlement reduction arising from reductions to the consumptive pool as a result of changes in climate and natural events such as bushfires and drought. Any risks associated with new knowledge or policy changes will be shared between water users and government according to an agreed formula. The risk-assignment policy is being developed in line with the national water reform agenda.

Water resource accounting

Water resource accounting in the region will be enhanced. This will ensure that adequate measurement, monitoring and reporting systems are in place to support public and investor confidence in the amount of water being extracted for consumptive use, traded, and allocated to the environment. Mandatory metering of water extraction will be phased-in across the state. Water resource accounting will also include water interception activities from unregulated land uses including large-scale plantation forestry, livestock and domestic farm dams and bores as well as overland flow storages.

Water reforms will see that policy, planning, management and/or regulatory measures are applied where necessary to land uses that intercept water, particularly where there is competition for water. This will protect the integrity of licences and WAE systems in the future and, importantly, the achievement of environmental objectives.

Trading of water entitlements

The trading of water entitlements is, and will remain, voluntary. Trading already takes place in the south west, particularly for groundwater allocations, although it is done on an ad hoc basis. A more efficient water market will be enabled by the new water legislation. One of the associated reforms involves the development of a publicly accessible water register of all WAEs and trades. The department will set the local rules for trading which will include the assessment of impacts on the environment and other users. Trading in WAEs may not be appropriate in all areas, and will be facilitated only in water resources subject to statutory water allocation plans.

2 The region and its challenges

Refer to the actions identified in the Strategic directions and actions *document under Theme 1: Understand water resources.*

The south west's water resources have important environmental and social values, with many waterways and wetlands of regional, state and national significance as well as wetland systems of international significance.

Human activities have significantly altered water regimes and diminished water quality in many south west catchments. A drying climate is a fundamental pressure on the region's water resources. Reduced rainfall and increased water-use are affecting groundwater levels and streamflows over most of the region, with many towns experiencing water restrictions.

A large number of high-value waterways and estuary systems in the region are under threat from:

- water storages
- artificial drainage
- exotic species
- pollutant input
- acid sulphate soils
- reduced rainfall
- groundwater abstraction
- flood control measures
- water interception
- agricultural intensification
- livestock grazing
- salinity
- land clearing
- nutrient and organic matter input
- irrigation
- mine dewatering
- urban development
- sediment build-up

The effects of these threats on water resource conditions include:

- altered streamflows
- fish passage blockage
- declining water quality
- weed infestation
- lowered watertables
- ecosystem fragmentation
- gully erosion
- increased mosquitoes
- sediment-filled pools
- fish and invertebrate deaths
- increased algal blooms
- stream bank erosion

In turn, these affect:

- biodiversity/conservation
- recreation
- ecological corridors/'hot spots'
- drought refuge
- tourism
- fishing
- habitat
- heritage and spiritual values
- riparian vegetation
- drinking water quality
- aesthetics/landscape
- aquaculture
- biofiltration
- flood conveyance/storage
- natural land drainage
- water supply/'useability'[2]
- Indigenous water-use
- bio-harvesting (flora and fauna)

[2] If water cannot sustain ecology, then most likely it will not support water supply without treatment

The Plan's response to many of these issues is addressed in the *Strategic directions and actions* document.

2.1 Human activities

Human activities have significantly altered water regimes and diminished water quality in many south west catchments. A drying climate trend and ongoing development will exacerbate many of these effects.

Water storages and altered flow regimes

Water storages such as dams and weirs alter flow regimes. The environmental impact of a single large water supply dam or the cumulative effect of multiple private on-stream and off-stream dams can be significant. Water storages modify surface water levels as well as the volume, velocity, duration, timing and/or frequency of flow events. Water storages can diminish the ecological functioning of waterways and wetlands and create conflict if flows are insufficient to support downstream uses (e.g. water supply, recreation, heritage or cultural values). This is particularly important during the summer low-flow periods. Poor water management outcomes can occur if sustainable diversions have not been determined, use is unlicensed or best-management practices are not applied (such as proper overflow and water release structures).

Altered flow regimes can exacerbate water quality problems, including salinisation, eutrophication (nutrients), acidification and sedimentation. Fast flows can scour riverbeds and banks, transporting sediment downstream to estuaries. In slow-moving flows, eroded soils may settle as silt in waterway pools. Stratification magnifies these problems and will occur over greater periods because of depressed flows.

Some of the region's river systems are highly regulated by multiple large dams. The Harvey River basin includes six Water Corporation dams for public water supply and irrigation water (Samson Brook, Waroona, Stirling, Harvey, Logue Brook and Drakes Brook dams). While all Water Corporation dams have operating licences and strategies, only a few dams (such as Harvey and Harris) have defined environmental water provisions.

When compared with design capacity, the region's reduced rainfall pattern is already resulting in the under-performance of most surface water supply dams. Public water supply dams have become less reliable due to reduced streamflow. For instance, a series of low rainfall years (2001, 2002 and 2004) in the Manjimup area resulted in insufficient runoff to fill the Manjimup and Phillips Creek public water supply dams. Stage 4 water restrictions in Manjimup were the result.

In developed catchments heavily reliant on surface water for private water supply, the combination of reduced rainfall and an increase in the number of self-supply on-stream and off-stream dams has led to community concerns about the long-term sustainability of the waterways. The growth in the number and storage capacity of on-stream dams has been most notable in the Busselton Coast river basin and the

Warren River basin. In a recent study of streamflows in the Busselton Coast river basin, streamflow data were compared for two periods: 1975–2003 and 1962–95 (DoW 2007f). A pattern of reduced mean annual streamflow emerged. Declines in the mean annual streamflow ranged from 8 to 36 per cent, with an average decline of 20 per cent.

Reduced rainfall not only decreases streamflow, but also decreases the continuity of flow that is available for dependent ecosystems. Disconnected pools are the result.

Groundwater abstraction

The most significant and productive groundwater resources of the south west are contained in the Yarragadee, Leederville and superficial aquifers of the southern Perth Basin, west of the Darling Scarp and east of the Margaret River (Figure 2).

The shallow (superficial) aquifers on the Swan and Scott coastal plains have served as a low-cost source of water that receives recharge from rainfall each year. The groundwater in the underlying Leederville and Yarragadee aquifers has been in storage for tens of thousands of years and, while the quantity of water is large, it is not all of it is available for consumptive use due to the costs of deep pumping and environmental impact considerations. Abstraction must be managed carefully to ensure adverse impacts are minimised or avoided.

Minor aquifers include the Lesueur aquifer, the highly faulted Sue Coal Measures and various isolated fractured rock aquifers. West of the southern Perth Basin are the granite outcrops of the Leeuwin Complex, extending from Cape Naturaliste to Cape Leeuwin. Groundwater supplies in the fractured rock aquifers of the Leeuwin Complex are small, localised and commonly brackish to saline, with limited potential for development. Fractured rock aquifers in the Yilgarn Block, east of the Darling Fault, tend to be brackish or saline and are generally low yielding.

The Collie sedimentary basin, also known as the Collie Basin or the Collie Coal Basin, contains substantial resources of groundwater important for both coal mining and power generation.

In the Collie Basin, groundwater levels are significantly lower than would occur in its natural state. This is a result of dewatering for safe mining purposes. Levels in parts of the basin where mining activity has ceased are slowly recovering. In areas where mining activity is still occurring, groundwater levels will continue to decline significantly.

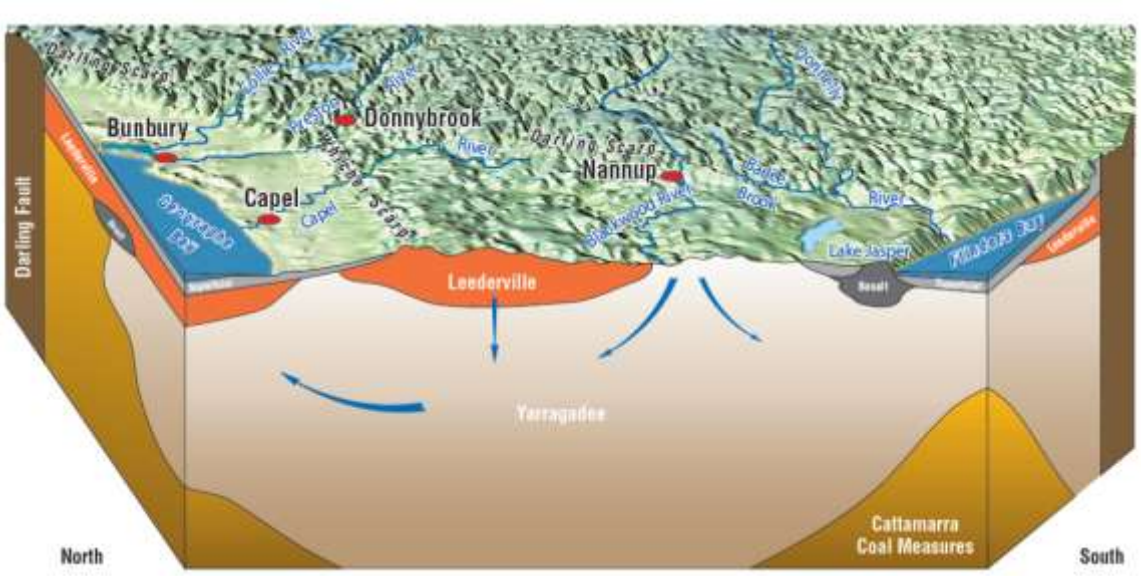


Figure 2 *Cross-section of southern Perth Basin aquifers (not to scale)*

All groundwater abstraction will reduce groundwater storage to some extent (indicated by a lowering of the level in a bore) and in many areas this can be managed on a sustainable basis. However, continuous groundwater abstraction in excess of its renewable capacity (recharge) will cause a net decline in water levels that may harm dependent terrestrial and aquatic ecosystems, such as wetlands and lakes. Abstraction from groundwater resources that are hydraulically connected to surface water may also reduce river flows through a reduction in the baseflow component. Reduced groundwater levels can also affect the performance of private and public water supply bores where eventually the cost of accessing water at greater depths will become cost prohibitive. In coastal areas, excessive groundwater abstraction also increases the risk of saltwater intrusion, making groundwater non-potable due to salinisation. The Department of Water carries out groundwater-level monitoring on a biannual basis for most monitoring bores in the south west groundwater areas. The Water Corporation constructed a bore-monitoring network on the Blackwood Plateau in 2003, but monitoring of water levels ceased in 2007. The general groundwater-level trends for the main aquifer systems and their probable causes are shown in Table 1.

Table 1 *Groundwater-level declines in the south west and probable causes*

Aquifer	Water-level decline	Probable causes
Superficial on Swan coastal plain	<1 m over the past 10 years	Reduced rainfall pattern
Superficial on Scott coastal plain	Either stable or declining gradually at a rate of about 5 cm/yr	Reduced rainfall pattern but also influenced by reduced water levels in underlying Yarragadee aquifer[3]
Leederville on Swan coastal plain	Net declines in the range of 1–2 m over the past 20 years	Consistent with localised abstraction for horticulture and rainfall decline
Leederville on Scott coastal plain	Generally stable with a decline of <1 m in winter/summer levels	Water-level declines may be due to increased levels of groundwater abstraction since 2003 for irrigated agriculture
Leederville on Blackwood Plateau	Generally stable with small declines in winter/summer levels	Groundwater levels are consistent with lower rainfall after 2001
Yarragadee in the Bunbury area	Relatively stable situation over the past 10 years in some areas, or steady decline of 0.5–2.5 m in other areas, averaging 0.5 m/yr declines in the past five years	Consistent with localised abstraction for horticulture and rainfall decline
Yarragadee in the East Bunbury area	Water levels have declined below sea level, increasing the likelihood of seawater interfaces moving inland	Consistent with localised abstraction for horticulture and rainfall decline
Yarragadee on Swan coastal plain (Leschenault Inlet to Ludlow and in the Boyanup and Dardanup areas)	Marked increase in the rate of decline since 2001	Consistent with localised abstraction for horticulture and rainfall decline
Yarragadee on Swan coastal plain (Capel area)	Steady decline until 2001 (0.5–1 m in summer) followed by a sharp increase in the rate of decline	Seasonal pumping by licence holders with large entitlements in the Capel and Busselton areas
Yarragadee in recharge area of Blackwood Plateau	Declined up to 1 m annually in the past few years	Localised abstraction in the Capel-Yoganup area and declining rainfall trends
Yarragadee on Scott coastal plain	Maximum decreases of up to 10 m in summer water levels	Localised abstraction affecting summer and winter water levels but where abstraction is not present, water levels are generally stable

Some waterways in the south west rely on groundwater discharge (baseflow) to support streamflows (DoW 2007f). Groundwater baseflow plays a significant role in supporting streams every summer. In the Scott River catchment, for example, groundwater-level declines in the superficial, Leederville or Yarragadee aquifers have the potential to significantly affect surface water flows. This is because the groundwater deficiency has to fill before surface flow occurs. To put this in

[3] Commander & Palandri (2007).

perspective, a 10 cm decline in the groundwater level could result in the Scott River's flow decreasing by about 20 GL, which is significant given the current mean annual flow is about 108 GL.

Groundwater decline can also contribute to water quality problems, including acidification and eutrophication. Algal blooms around the Scott River have resulted in warnings against recreational usage of the waterways in 2007, 2008 and 2009.

Land clearing, drainage and flood control

Past land clearing, artificial drainage networks and structural flood controls (e.g. floodgates and diversion drains) enabled agricultural production and later urbanisation on the Swan coastal plain. These changes have also dramatically altered water regimes.

Extensive clearing of native vegetation resulted in elevated watertables and increased streamflows. This caused waterlogging, salinity, reduced agricultural productivity and increased potential for erosion and sedimentation of waterways. To manage salinity or to control flooding in rural areas, drainage systems were installed to drain waterlogged agricultural soils.

In urban areas, drainage networks were put in place to manage stormwater, groundwater and floods. Urbanisation has dramatically increased the amount of impervious surfaces (e.g. roads and roofs). This has altered the pattern of groundwater recharge and increased runoff and the transport of nutrients and pollutants.

Land clearing, drainage and groundwater abstraction have been major factors in the loss of wetlands on the Swan coastal plain. The remaining wetlands are under pressure from reduced waterway flows, altered watertables, drainage, development, salinity, acidity, pollutant discharge and weed encroachment.

Flood control efforts near populated and agricultural areas have altered water regimes through the straightening of watercourses and the construction of levee banks, detention basins, diversion drains and floodgates.

Sedimentation

Many of the region's waterways have been altered by straightening, deepening and flow diversion, resulting in erosion pressures that mobilise bed and banks. Sediment discharge to waterways has also increased due to activities such as land clearing, poor cultivation practices, clearing of fringing vegetation, uncontrolled grazing by livestock, urban development and dredging. The undesirable effects on waterways include increased siltation and turbidity, smothering of aquatic ecosystems and reduced light penetration causing changes to the water regime. As a result of sedimentation, some waterways such as the Brunswick River no longer have the deep pools that are a historical characteristic of waterways in the south west.

Flood control and drainage works have had a dramatic impact on the lower Vasse River and Vasse-Wonnerup Estuary. The Vasse Diversion Drain, built in 1927 to

prevent flooding in Busselton, has limited flows to the lower Vasse River – greatly reducing flushing and diminishing flows into the Vasse Estuary. Excess sediments, nutrients and organic material from urban, industrial and rural catchments now drain into the lower Vasse River. These inputs, combined with the reduced flows, have resulted in eutrophic conditions including algal (cyanobacteria) blooms, which in recent years has forced the waterway's closure to public use during the warmer months.

Sediment build-up can exacerbate flooding where channels become shallower and outlets are blocked. This in turn can increase flood magnitude and frequency. The Leschenault Estuary and lower Collie and Preston rivers have been reshaped by dredging, straightening and the construction of levee banks. These alterations, combined with urban and agricultural activities in the catchment, have resulted in significant sedimentation of the Leschenault estuarine system.

Sediments can transport significant loads of nutrients, heavy metals and organochlorines, as these materials bind to sediment particles. Waterways with sedimentation issues include the Harvey, Brunswick, lower Collie, Preston, lower Blackwood and Vasse rivers, the Leschenault and Vasse-Wonnerup Estuary and the Hardy Inlet.

Nutrients

Intensive animal and horticultural industries, broadacre agriculture, urban runoff, wastewater treatment plants and septic tanks are the major sources of nutrients in waterways, including estuaries. Elevated loads of nutrients (nitrogen and phosphorus) can result in algal blooms, which in turn may adversely affect coastal waters by preventing light reaching benthic plants and producing toxins detrimental to animal and human health. The decay of algal blooms can prevent recreational activities, affect amenity values and reduce the amount of dissolved oxygen available to aquatic life, sometimes causing fish kills. Table 2 sets out the waterways prone to algal blooms in the south west.

Table 2 *Algal-bloom-prone waterways in the South West*

Waterbody	Significant dinoflagellate blooms	Significant cyanobacteria blooms	Excessive macrophyte growth	Fish kills	Recreation impacts	Potential shellfish poisoning
Leschenault Estuary	√		√			√
Brunswick River	√			√		
Collie River				√		
Vasse-Wonnerup Estuary		√	√	√	√	
Vasse River		√	√	√	√	
Hardy Inlet		√			√	
Blackwood River		√		√	√	

Data source: EPA 2007a

Nutrient enrichment of groundwater is typically a result of excessive fertiliser usage, poor management of animal waste and the use of septic tanks. This enrichment can reduce the suitability of groundwater for potable supply and impact on sensitive environments supported by groundwater, such as estuaries, wetlands and cave systems.

In the south west, estuaries receiving surface water and groundwater from catchments with urban and intensive agricultural areas suffer from nutrient enrichment. Nitrogen and phosphorus levels in both the Leschenault and Vasse-Wonnerup estuaries exceed the ANZECC and ARMCANZ[4] (2000) water quality guidelines for estuaries. The Vasse-Wonnerup estuarine system has the highest nutrient loads, with 51 per cent of the total phosphorus (TP) and 21 per cent of the total nitrogen (TN) coming from point sources, including septic tanks (14 per cent TN; 34 per cent TP). Diffuse sources contribute 79 per cent of TN and 48 per cent of TP, with the largest contribution coming from pastures (Kelsey 2004).

An opportunity exists in the Vasse-Wonnerup system to explore diverting the first flush of nutrients down the Abba River into the Wonnerup system. This would reduce the load on the Vasse system in the first instance, with the additional benefit that the Wonnerup system dries out during summer, thus burning off the nutrients. These types of opportunistic management practices could significantly reduce the adverse impacts of excess nutrients in waterways.

In the Hardy Inlet's case, the much smaller Scott River catchment contributes a disproportionate nutrient load (particularly of TP) compared with the Blackwood River catchment. This is due to intensive agriculture on the Scott coastal plain, the low nutrient-retention capacity of its soils and high rainfall in the catchment (WRC 2002).

Under normal circumstances, the Scott River has a high level of tannins that suppresses the expression of the elevated nutrient levels. Recent significant algal blooms in the river may be caused by lower tannin levels, which arguably may be the result of low rainfall mobilising the humic acid out of the subsurface ironstone formations.

Salinisation

Decades of land clearing have contributed to increased salinity levels in many rivers in the south west. When water becomes too salty it is not suitable for some uses, such as drinking water. Many freshwater organisms (e.g. native fish species) cannot tolerate high levels of salinity. Elevated stream salinity can result in changes to aquatic biotic communities, the loss of important microhabitats and reduced biodiversity. Salinity affects riparian vegetation and increases the potential for bank erosion. A study is required to determine the capacity of native aquatic fauna to tolerate varying salinity levels. The impact of salinity on the spatial distribution of some of the aquatic species could then be determined.

[4] Australia and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand

Elevated salinity levels create economic and social impacts, including a reduction in the suitability of water for public water supply, irrigation and industrial applications.

Appendix C displays the national water quality guidelines for salinity and the salinity status of the south west's waterways. The *Australian drinking water guidelines* (NHMRC & NRMMC 2004)[5] set the desired level of total dissolved solids (TDS) at no more than 500 mg/L for public drinking wate.

Salinity levels in the superficial aquifer are greater than 1000 mg/L TDS over half of the Swan coastal plain. The Leederville and Yarragadee aquifers are generally fresh. In the Collie Basin, groundwater is generally fresh, but in areas closer to the Collie River South Branch, where the river recharges groundwater, salinity is between 1000 mg/L and 2000 mg/L TDS.

Stream salinity in the south west shows a clear relationship between land clearing and mean annual rainfall (Mayer, Ruprecht & Bari 2005). Rivers with little clearing of native vegetation in their catchments are fresh (i.e. they contain concentrations of 500 mg/L TDS or less). Largely cleared catchments experiencing less than 800 mm rainfall are often moderately saline to saline.

Waterways are fresh in areas with more than 900 mm of mean annual rainfall. Some exceptions are the Collie, Blackwood and Warren rivers, which have catchments that extend well inland to areas of low rainfall and significant clearing (Mayer et al. 2005). These waterways are more saline in the upper (i.e. inland) catchments. As the waterways flow toward the ocean, they become less saline as they pass through higher-rainfall areas and benefit from inputs of fresh groundwater and fresh water tributaries. The movement of salt down the length of waterways in the south west takes considerably longer than the hydraulic increases in flow. Further investigations into how saline slugs of water move through these waterways are needed.

Irrigation salinity is already a problem in some irrigated areas with poorly drained soils and shallow, naturally saline groundwater. Salt scalds are already evident in some areas of the Harvey River catchment (Mayer et al. 2005).

In 1996 the state government designated the catchments of the Collie and Warren rivers as water resource recovery catchments (WRRCs) for salinity management. These catchments contain current or potential water supply sources predicted to deteriorate beyond recovery without active management. The salinity target for the Collie River catchment is 500 mg/L TDS (i.e. fresh) at Wellington Reservoir by 2015 (currently about 1000 mg/L TDS). The Warren River target is 500 mg/L TDS at Barker Road Crossing by 2030 (currently about 800 mg/L TDS).

Water interception by plantation forestry

Plantation forestry is an increasingly important land use in the south west, with new plantations being established across large areas of cleared land formerly used for agriculture. There are sound environmental and economic arguments for strategically

[5] National Health and Medical Research Council & Natural Resource Management Ministerial Council 2004

located plantation developments, but in some circumstances proposed plantations may have detrimental effects on surface water runoff and groundwater recharge.

The national water reforms require that land-use changes with the potential to intercept significant volumes of surface water and/or groundwater (e.g. the construction of farm dams and large-scale plantation forestry) be subject to planning and regulation to protect water rights and environmental objectives where systems are fully allocated, over-allocated or approaching full allocation.

Trees are essential to the recovery of dryland salinity because of their capacity to lower groundwater levels in shallow aquifers. More recently, tree plantations in the lower-rainfall areas have become a mechanism for carbon sequestration. High rainfall, good land capability and the popularity of managed investment schemes[6] has resulted in a significant increase in private tree plantations in the south west; for example, in the Shire of Manjimup.

However, plantation forestry operations intercept runoff and groundwater recharge, leading to impacts on surface water and groundwater resources, particularly in higher-rainfall areas. Plantations siphon shallow groundwater directly through their root systems. In addition, farm forestry activities can damage water quality by way of aerial spraying that uses significant quantities of pesticides. These pesticides can eventually reach the waterways.

Where water interception by plantation forestry results in a noticeable increase in competition for available resources, regulation may be required to protect the integrity of existing water rights and the achievement of environmental objectives into the future.

Failure to account for and manage interception by large-scale plantation forestry will weaken the integrity of the licensing and future water access entitlement (WAE) framework. This is especially so where land use is changing rapidly or water availability is declining due to a drying climate.

Water interception by farm dams

The South West region is characterised by numerous self-supply dams to support irrigated agriculture. Most are located on watercourses. While the impact of an individual farm dam may be small, the cumulative impact of a large number of dams can have a significant effect on streamflows. Farm dams often have the greatest impact on early winter flows, as this is when dams fill after extended dry periods.

Acid sulfate soils

Acid sulfate[7] soils (ASS) are naturally occurring soils and sediments containing iron sulfides, most commonly pyrite. ASS are normally found in low-lying coastal areas although they may also occur higher up in the catchment. In the south west they are

[6] The popularity of managed investment schemes has reduced in recent times

[7] Can also be spelt as ‘sulphate’

more likely to be found in the Swan and Scott coastal plains and frequently occur in low-lying wetlands, back swamps, estuaries, salt marshes and tidal flats.

ASS that have not been oxidised by exposure to air are known as potential acid sulfate soils and are relatively harmless in their undisturbed (saturated) natural state while contained in waterlogged soil. When exposed to the atmosphere through excavation, dredging or lowering of the watertable, these soils may generate a variety of iron compounds and sulfuric acid. Initially a chemical reaction, the process is accelerated by soil bacteria. The resulting acid can release other substances, including heavy metals, from the soil and into the surrounding waterways and wetlands. Climatic factors (such as reduced rainfall) that lead to water-level decline can also contribute to the oxidation of ASS.

Disturbance and oxidation of ASS due mainly to declining watertables, is an emerging water management issue in the region, although the extent to which they degrade water resources is still being investigated. A review of pH[8] changes for eight sites on the Scott coastal plain between 1999 and 2005 revealed that the pH is declining, that is, tending towards acidic water. Potential environmental and economic impacts include contamination of groundwater resources, fish kills, loss of biodiversity in wetlands and waterways, loss of agricultural productivity and corrosion of concrete and steel infrastructure. Under the *Contaminated Sites Act 2003* (WA), areas of disturbed acid sulfate soils may be considered 'contaminated' and, if the contamination is sufficiently severe, remediation may be required.

The Department of Environment and Conservation (DEC) has mapped, at a broad scale, the areas most at risk of developing acid sulfate soils (Figure 3) (DEC 2007). More detailed information on acid sulfate soils can be found on the DEC's website:

<www.dec.wa.gov.au/management-and-protection/acid-sulphate-soils/index.html>.

[8] pH is a measure of acidity or alkalinity on a scale running from 1 (extreme acidity) to 14 (extreme alkalinity) – natural water is about 7 on the scale.

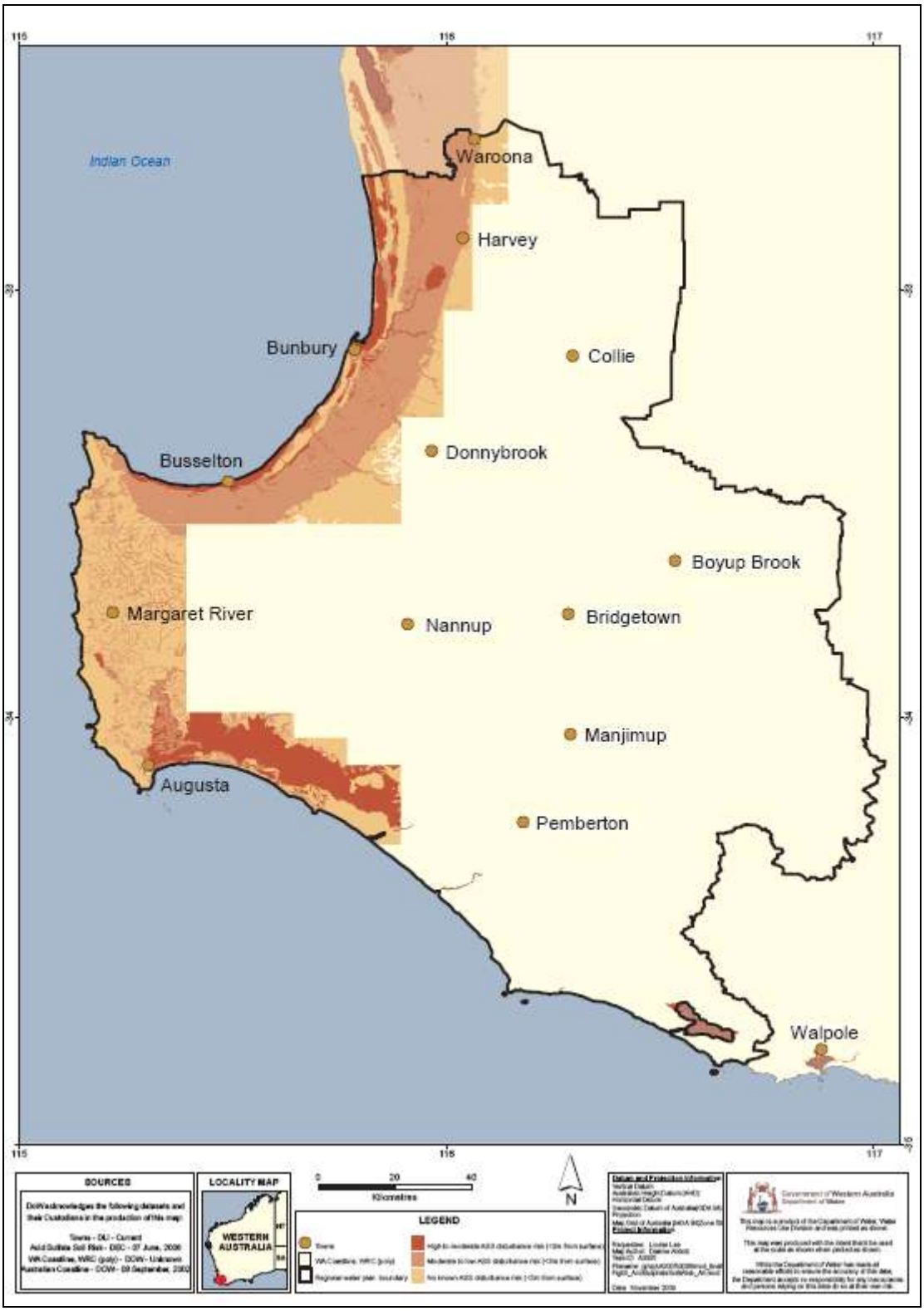


Figure 3 *Areas at risk of developing acid sulfate soils*

2.2 Climate considerations

Climatic trends provide an insight into any 'net' change in climate over time, whether due to natural causes or as a result of human activity. Climate variability refers to the seasonal variations in the mean state. The South West region is experiencing a drying climate trend that will most likely exacerbate climate variability. There is a developing trend of winter rainfall starting later, while episodic summer events are increasing. The variability of rainfall through time will affect the availability of both surface water and groundwater.

A drying climate is one of the most complex and serious challenges facing society today (EPA 2007a). Over the coming century, increased temperatures (hence increased evaporation and transpiration), drier conditions and more frequent extreme events such as extreme rainfall, bushfires and droughts are expected in the south west. These events will impact on the region's water resources with expected decreases in surface water flow, groundwater recharge and baseflow, water availability and water quality, and an expected increase in demand for water.

The sharing (allocation) of the available water between the environment and consumptive uses must be adapted to this drying climate by using real rainfall input and then allocating a portion of the available water to each system. This will allow for realistic and more accurate accounting for water.

This type of real time accounting of the total water resource eliminates the double counting of water in connected surface water/groundwater systems when it moves from one system to another. This process may also enhance protection of the water resource and enable the water allocation process to be enacted with a degree of security and safety for those depending on it.

Historical rainfall pattern

Long-term annual rainfall trends since European settlement show multi-decadal swings from drier periods (e.g. 1880–1910) to wetter periods (1914–1969) and more recently a drying trend (1975–present).

The south west experiences hot dry summers and cool wet winters. About 75 per cent of annual rainfall occurs between May and September. The highest rainfalls occur in the south-western Darling Range (average 1100 mm/yr) and in southern areas about 10–20 km inland from the south coast (average 1200 mm/yr) (Figure 4). Rainfall declines rapidly further inland, especially in the region's north, where average rainfall is less than 700 mm/yr in some areas. In most of the region, approximately 80–90 per cent of rainfall is lost to evapotranspiration.

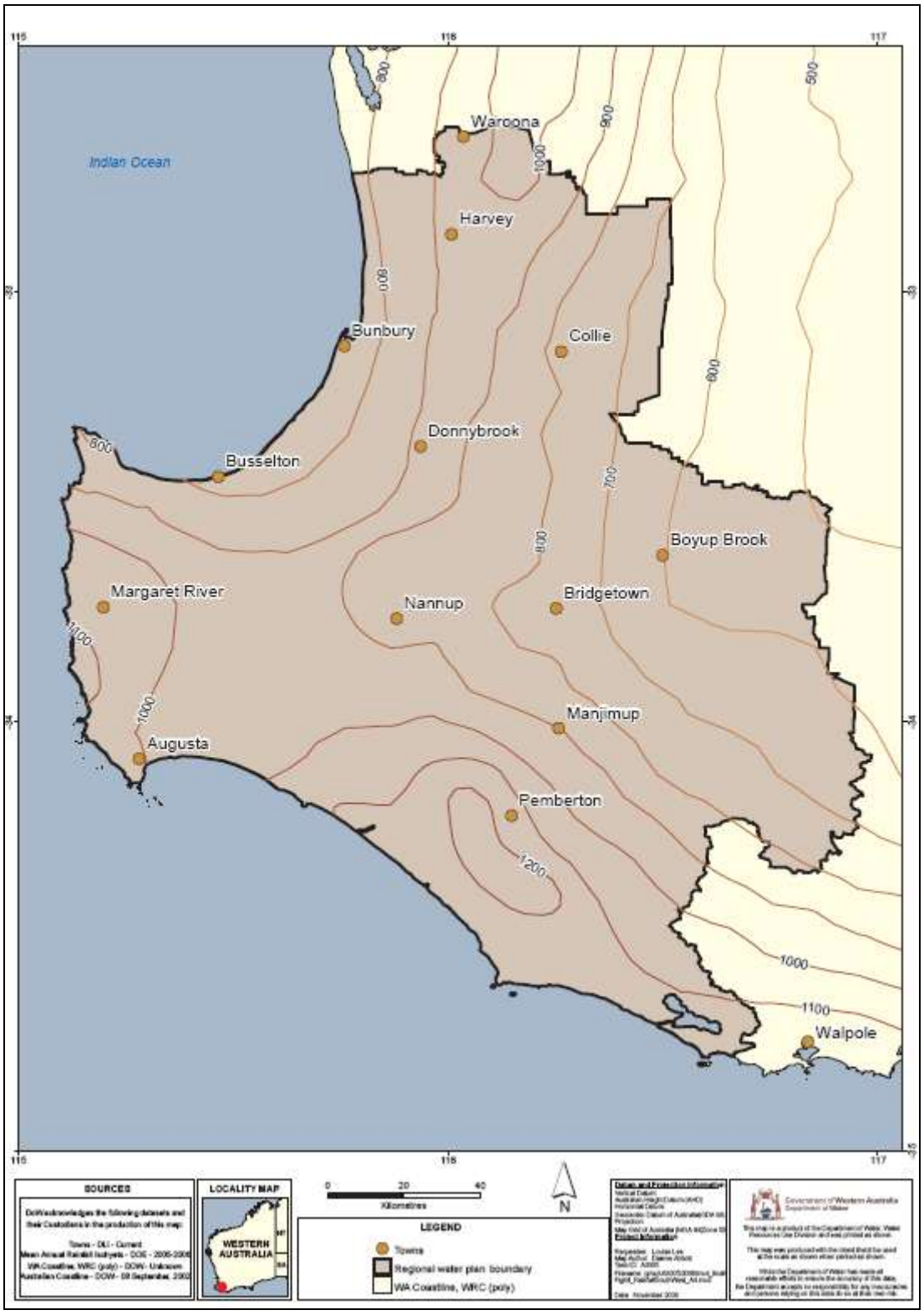


Figure 4 *Average annual rainfall (mm) in the South West (1975–2003)*

Post-1975

Since 1975 winter rainfall across the south west has decreased by up to 15 per cent compared with the period 1925–75 (Ryan & Hope 2006), resulting in a potential decrease in runoff of about 40 to 50 per cent. While it is still too soon to state the matter with confidence, the period since 1995 may reflect a second downward step in the rainfall profile.

Because only a small proportion of annual rainfall (approximately 3–20 per cent) ever becomes streamflow, even a small decrease in rainfall can result in a significant decrease in the amount of water in the region's rivers and reservoirs. The effects of this protracted period of reduced rainfall are reflected in the region's water resources. For example, between 1975 and 1992, the Harris River near Collie experienced only 40 per cent of the streamflow recorded between 1958 and 1975.

Rodgers and Ruprecht (1999) assessed the impact of climate variability on surface water resources in the region and determined that major changes had occurred in the hydrology of forested catchments.

An uncertain future

Climate systems are complex and by their nature difficult to predict. Some natural variation in climate occurs from decade to decade and on much longer time scales. However, our understanding of the drying climate and its implications is improving through programs such as the Indian Ocean Climate Initiative (IOCI) (Ryan & Hope 2006). In partnership with state government agencies, the CSIRO and the Bureau of Meteorology, IOCI is systematically investigating changes in the climate pattern of Western Australia.

A likely scenario in the south west would see median winter rainfall decline by 2–20 per cent by 2030, compared with average rainfalls in the 1960–90 period (see www.ioci.org.au). This projection is consistent with annual average declines in rainfall of 5–11 per cent relative to 1990 (Hennessy, Macadam, Whetton 2006; CCA 2007). In the period 1990–2070 average temperature rises of 0.1–0.65°C per decade could occur in the state's southern areas (Cramb 2005). By 2030, catchments across the south west could experience decreases in runoff in the range of 5–40 per cent relative to 1990, with the amount of runoff generally decreasing by two to three times the decrease in rainfall (Berti, Bari, Charles & Hauck 2004; Kitsios, Bari, & Charles 2006).

When climatic variability is considered, it is uncertain whether the relatively dry conditions experienced during the past three decades will continue in the short to medium term (the next few years to several decades). Nevertheless, the likelihood of a continued drying trend is high. In the coming years, the increased probability of combinations of reduced rainfall, reduced streamflows and reduced groundwater recharge, together with higher average temperatures and evapotranspiration, could further decrease the amount of water available while at the same time cause demand to increase.

If the declining rainfall trend continues, which is expected, it will result in the under-performance of some surface water supply systems when compared with design capacity. This will place greater pressure on groundwater sources and alternative supplies to meet the growing demand for water. A discussion on impacts of a drying climate on groundwater (Commander 2000) outlines the variability of groundwater responses and the need for improved knowledge of recharge responses. Although any changes in recharge will depend on impacts of changed land use and climate, a reasonable guiding assumption is that groundwater recharge reductions may occur at one-and-a-half to twice the rate of rainfall reductions.

In 1999 the Water and Rivers Commission (now the Department of Water) rationalised the rainfall recording network in the south west, which resulted in the removal of around 20 rainfall gauges (pluvios). It has since been recognised that the pluvio network was reduced to a level that made the coverage inadequate for appropriate trend analysis. It is important for the Department of Water to evaluate the existing pluvio network and install additional gauges to ensure adequate coverage.

Department of Water response to a drying climate

As the state's lead agency for water resource management, the Department of Water will take into account in its decisions the potential effects of a drying climate and its associated uncertainties. This will occur in a variety of ways, including:

- forming public and private-sector partnerships to achieve greater demand management in all water-use sectors
- requiring water efficiency plans as part of applications for water licences
- considering alternative water resources (e.g. stormwater, rainwater, wastewater, desalination, non-potable quality water) as potential water supply options in water planning
- adopting a total water cycle management philosophy
- adopting the post-1975 period as the primary period of average rainfall record applied in water planning and modelling, with adjustments to reflect recent drying conditions and climate projections that are consistent with planning horizons:
  - short-term (2005–10): adopt 'standard period' average rainfall of 1975–2003 with risk factors stated
  - medium-term (2010–20): decrease standard period average rainfall by 5–8 per cent
  - long-term (2020–30): decrease standard period average winter rainfall by 8–11 per cent
- applying multiple climate scenarios (reflecting the range of potential outcomes including climate variability) to test the sensitivity of water management rules and decisions
- developing and maintaining skills for predicting impacts of a drying climate on water balance and water availability
- requiring that all water management plans describe the potential effects of a drying climate and how they will be managed
- applying adaptive management to meet targets
- continuing participation in the Indian Ocean Climate Initiative
- reviewing, coordinating and enhancing the department's water monitoring efforts.

A drying climate and water quality

A reduction in rainfall runoff primarily affects the flow regimes of waterways, which ultimately impacts on water quality (potentially leaving sources unsuitable as potable water supplies). Less water flow will result in contaminants remaining in place longer, but significant storm events could result in pulses of contaminants (nutrients, chemicals and salt) discharging to waterways and into estuaries. The distribution and timing of rainfall in the south west would be significantly impacted by a drying climate beyond changes in the mean annual flow such as:

- reduced groundwater recharge resulting in reduced baseflows to waterways
- a later start and earlier finish to winter flows
- changes to water quality
- changes to water-flow-dependent ecologies

- reduction in the length of waterways with continuous water flow 12 months of the year (resulting in disconnected pools).

Changes to summer rainfall will have a significant impact on the availability of water because:

- the water quality of the waterways will be affected by events such as algal blooms causing fish deaths from oxygen deficiency (anoxic)
- of changing water temperatures
  - more sunlight results in algal blooms that render water non-potable
  - some ecologies also depend on maximum and minimum water temperatures
- of increased concentration of nutrients due to less water dilution
- of episodic events washing salts into waterways at critical times of the year
- stratification of waterways and dams that changes the suitability of water for consumption
- of reduced riparian vegetation removing the protection of waterways from sediment mobilisation
- of increasing the time that salts are washed out of the soil profile, thus extending the temporal and spatial distribution of impacts on agricultural activities.

Water quality changes that impact on the availability of water include:

- acid water production
- increased nutrient concentration
- pollution sources not diluted
- increased salinities
- lower flushing of estuarine waters
- longer periods of stratification
- increased water temperatures
- dam capacities that may preclude flushing of waterways.

2.3 Waterways and wetlands values and threats

Significant waterways and wetlands

The region has many waterways and wetlands of regional, state and national significance, as well as four wetland systems of international stature: the Ramsar listed Peel-Yalgorup system (including Lake Preston), the Lake Muir-Byenup Lagoon system, Benger Swamp and the Vasse-Wonnerup system). Internationally and nationally significant waterways and wetlands are shown in Figure 5.

Waterway assessment

In 2006 an expert-panel approach was used to rate waterway assets in the south west in terms of their economic, social and environmental values and the degree of threat they face (Government of Western Australia 2007)[9]. Table 3 shows the results of the value threat assessment.

Most high-value assets located in highly developed catchments are under significant threat. These include the Leschenault, Wilyabrup and Margaret rivers, Hardy Inlet and Vasse-Wonnerup Estuary. High-value waterscapes in the Scott coastal plain, lower Blackwood region, Leeuwin-Naturaliste Ridge and Swan coastal plain also face a high level of threat.

Most of the high-value assets under low threat are found in Wild River catchments in the Shannon River basin. These include the Doggerup Creek, Blackwater Creek, Shannon River, Inlet River and Forth River catchments. Broke Inlet, at the mouth of the Shannon River, is the only estuary in near-pristine condition in the south west. These catchments are within national parks and face little threat at present.

The efforts of the South West Catchments Council to develop a waterways health plan based on a geographical information system (GIS) approach could contribute to the future management of region's waterways.

Significant waterways and wetlands include those classified as Ramsar wetlands or Wild Rivers, those in the *Directory of important wetlands in Australia* (DIWA), those on the Register of the National Estate (RNE) and in the conservation estate, conservation category wetlands, water-dependent threatened ecological communities and environmental protection policy (EPP) wetlands. Other significant waterways and wetlands are identified in Chapter B5.2.2 and B4.2.2 in the *Environmental guidance for planning and development – guidance statement no. 33* (EPA 2008). DIWA, Ramsar, Wild Rivers and RNE wetlands are identified in Table 3.

[9] Note: a new version will be released in 2010.

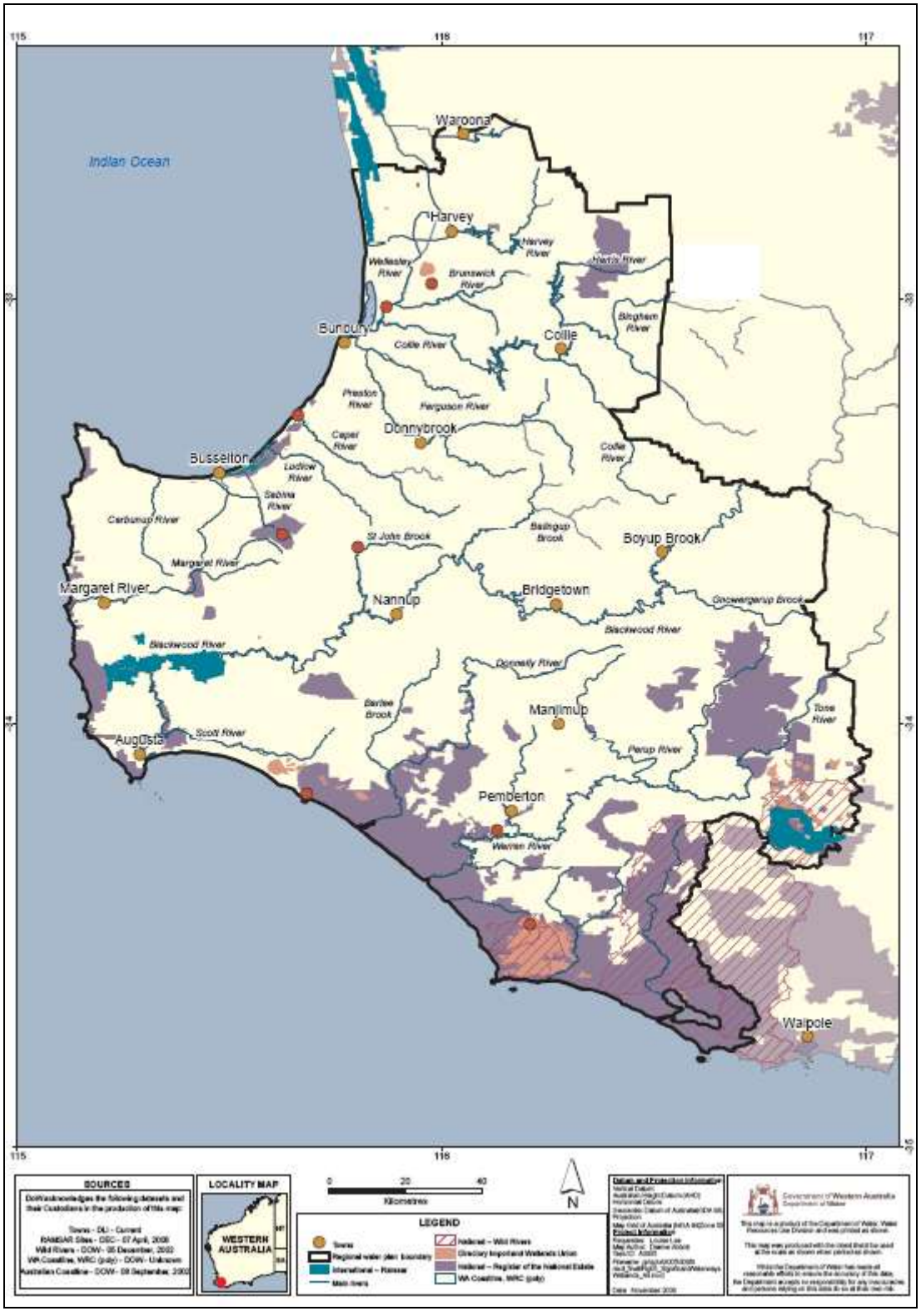


Figure 5 *Internationally and nationally significant waterways and wetlands*

Table 3 *Broad assessment of waterway and wetland values and threats*

	High value	Medium value	Low value
High threat	• Brunswick River (RNE) • Broadwater wetland (RNE) • Collie River (RNE) • Cowaramup River (RNE) • Carey Brook (RNE) • Gingilup-Jasper wetland system (DIWA) • Hardy Inlet estuary • Leeuwin Ridge streams (RNE) • Leschenault Estuary • Lower Blackwood River and tributaries (DIWA and RNE) • Margaret River and estuary (RNE) • Milyannup Brook (RNE) • Muir/Unicup system[10] (Ramsar, DIWA and RNE • Peel-Yalgorup system (Ramsar) • Poison Gully (RNE) • Reedia complexes • Scott coastal plain wetlands (RNE) • Scott River (RNE) • St Johns Brook (RNE) • Vasse-Wonnerup Estuary and wetlands (Ramsar, DIW and RNE) • Wilyabrup River and estuary (RNE) • Yalgorup lakes (DIWA)	• Abba River (RNE) • Barlee Brook • Gunyulgup Brook estuary (RNE) • Ludlow River (RNE) • Margaret River wetlands • Sabina River (RNE) • Toby Inlet estuary • Vasse River (RNE) • Wellesley River (RNE)	Upper Blackwood River above Boyup Brook (DIWA)
Medium threat	• Benger Swamp (DIWA and Ramsar) • Cape Leeuwin system (DIWA and RNE) • Donnelly River and estuary (RNE) • McCarleys Swamp (Ludlow Swamp) (DIWA and RNE) • Warren River estuary (RNE)	• Capel River • Capel River estuary • Ferguson River • Harvey River • Kemerton wetlands • Leschenault Inlet • Perup River • Preston River • Stirling wetlands • Tone River	Mid Blackwood River, Boyup Brook to Nannup (DIWA)

[10] Also known as Lake Muir-Byenup lagoon system

	High value	Medium value	Low value
	• Wilga wetlands		
Low threat	• Blackwater Creek (Wild River and RNE) • Broke Inlet (DIWA and RNE) • Doggerup Creek system (Wild River, DIWA and RNE) • Forth River (Wild River and RNE) • Inlet River (Wild River and RNE) • Lake Maringup (DIWA) • Shannon River (Wild River and RNE)		

Abbreviations

Ramsar	Recognised internationally as a 'Ramsar' wetland, principally for significance as habitat for migratory bird species. The Ramsar Convention on Wetlands is an international treaty for conservation and wise use of wetlands and resources.
Wild River	Recognised nationally as a Wild River catchment
DIWA	Recognised nationally in the latest version of *A directory of important wetlands in Australia* (Environment Australia 2001)
RNE	Partly within an area recognised nationally for its heritage values on the Register of the National Estate.

2.4 River basin characteristics and conditions

The south west comprises (from north to south) the Harvey, Collie, Preston, Busselton Coast, Blackwood, Donnelly, Warren and Shannon river basins, and a small portion of the Murray River basin which will not be discussed in this document (Figure 6). Tables 4 and 5 provide a brief summary of each basin's characteristics and conditions.

The Margaret River catchment forms part of the Busselton Coast river basin and although not shown in Table 4, is worthy of a separate mention because of its defining characteristics (see below).

Defining characteristics:	• river pools remain during summer • Margaret River estuary • significant population growth projected • significant viticulture industry • plantation forestry • significant wetlands.
Major water users:	• public water supply by water service provider • groundwater and surface water agricultural use
Flow regime:	• summer pools in Margaret River fed by Leederville groundwater

Land clearing:	• Only partly cleared in lower catchment

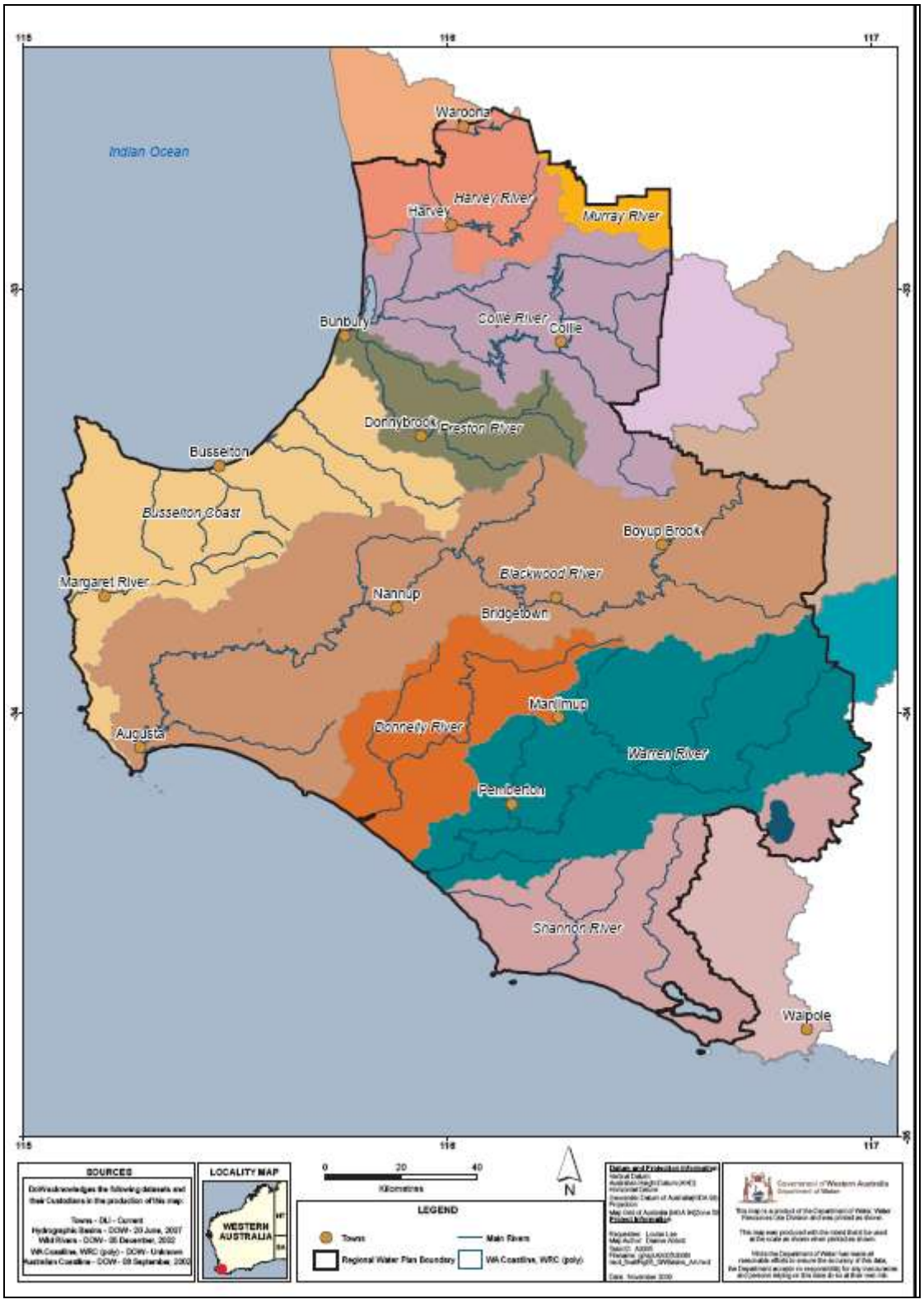


Figure 6 *South West river basins*

Table 4 *River basin characteristics and conditions (northern basins)*

Attributes	River basins			
	Harvey	**Collie**	**Preston**	**Busselton Coast**
Defining characteristics	Large irrigation districts Significant nutrient contributions to the Peel-Harvey estuarine system	Leschenault Estuary State's primary coal mining and power generation centre Wellington Dam	Significant population growth projected on coastal plain	Significant population growth Ramsar listed Vasse-Wonnerup wetland system Major tourist destination; premier grape growing area and wineries Karst areas along Leeuwin-Naturaliste Ridge Capel River has high groundwater contributions
Major water uses	Irrigation (Waroona and Harvey districts) Bauxite processing Integrated Water Supply System (IWSS)	Irrigation Kemerton Industrial Park Australind groundwater scheme Great Southern towns water supply scheme Coal-mine dewatering and energy production at Collie	Preston Valley Irrigation Cooperative Groundwater is used for public water supply, agriculture, mining and industry	Groundwater and surface water used to meet self-supply needs of agriculture (market gardens, vineyards, dairy and beef) Margaret River town water supply scheme Public water supply (Busselton-Dunsborough area)
Flow regime	Six Water Corporation dams on the Darling Scarp Coastal plain highly modified by artificial drainage and irrigation	Groundwater abstraction exceeds annual recharge in parts of Collie Basin Wellington Dam controls flows in lower Collie River Coastal plain modified by artificial drainage and irrigation Piping the irrigation water for efficiency gains results in reduced summer baseflows	Lower Preston River is highly modified through drainage, realignment and levees Flood protection for Bunbury only 100-year ARI	Flood control and artificial drainage systems have altered water regimes in the Geographe Bay catchment Many unlicensed on-stream dams for self-supply in Cape to Cape subregion Declining rainfall is drying out caves in karst areas (there is evidence to show that high water interception/low infiltration by the understorey is the cause
Land clearing	Coastal plain is extensively cleared	Extensively cleared. Some reforestation in upper catchment	Coastal plain is extensively cleared	Coastal plain is extensively cleared

Table 5 *River basin characteristics and conditions (southern basins)*

Attributes	River basins			
	Blackwood	**Donnelly**	**Warren**	**Shannon**
Defining characteristics	Major recreational waterways Lake Jasper – largest freshwater lake in region Yarragadee provides fresh water to base flow in summer in lower reaches	Largest undeveloped fresh surface water resource in region Important recreational fishery Largest diversity of native fish	Important recreational fishery	Wild River catchments and Ramsar wetlands Broke Inlet – region's only estuary in near-pristine condition
Major water uses	Public water supply Agriculture on the Scott coastal plain	Small number of self-supply users in upper catchment Tourism	Self-supply for Manjimup-Pemberton agricultural area Towns of Pemberton and Manjimup	Small amount of self-supply use in the Northcliffe area (domestic and agriculture)
Altered flow regimes	Land-clearing and artificial drainage have altered the water regime on the Scott coastal plain	No large dams on system	Many on-stream dams along the Lefroy Brook	No significant storages or flow modifications
Water quality issues	Elevated salinity in the Blackwood Sedimentation in the Blackwood River and Hardy Inlet Elevated phosphorus in Hardy inlet and recent occurrence of algal blooms and fish kills	Good water quality and generally fresh Sparse water quality data	Includes 'water resource recovery catchment' for salinity in upper catchment Sparse water quality data	No water quality issues
Land clearing	Middle and upper catchments are extensively cleared	Catchment is largely uncleared	Extensive clearing of upper catchment	Catchment is almost entirely uncleared

3 Water availability and demand

Refer to the actions identified in the South West regional water plan 2010-30 under Theme 2: Enhance the security of water resources for the environment and users.

3.1 Water availability

Failure to adhere to the sustainable yield or allocation limit of a water resource can result in over-allocation and lead to over-use. Over-use occurs when the amount of water withdrawn from a water resource over a particular period, generally a year, is greater than its ability to replenish itself over the same period. For groundwater, over-use results in a loss of storage which is reflected in a net decline in the water level.

Not all the water in a water system is available for consumptive use. Some water needs to remain in the system to support dependent ecosystems and social benefits such as cultural and recreational values. For groundwater systems, care must be taken to set the allocation limit at a value that will not compromise some of the less obvious benefits such as maintaining baseflows in waterways or keeping the saltwater interface along the coast from moving further inland.

Groundwater resources

Revised water allocation limits have been determined in the *South West groundwater areas allocation plan* (DoW 2009a) and the *Upper Collie allocation plan* (DoW 2009b). Revised allocation limits are based on the use of all available data to determine the amount of water that can be abstracted without adversely affecting dependent environmental or social values. Data includes measured groundwater level and quality, water abstraction and modelling using the South West Aquifer Modelling System (SWAMS).

Figure 7 presents the current level of water allocation as a percentage of the allocation limits for the South West region's five groundwater areas (South West Coastal, Bunbury, Busselton-Capel, Blackwood and Collie) and includes the superficial, Leederville and Yarragadee aquifers.

A drying climate is likely to significantly affect future groundwater availability in the region. Current projections indicate up to a 10 per cent reduction in 1990 average rainfall levels by 2030. This is estimated to reduce groundwater recharge by about 15–20 per cent.

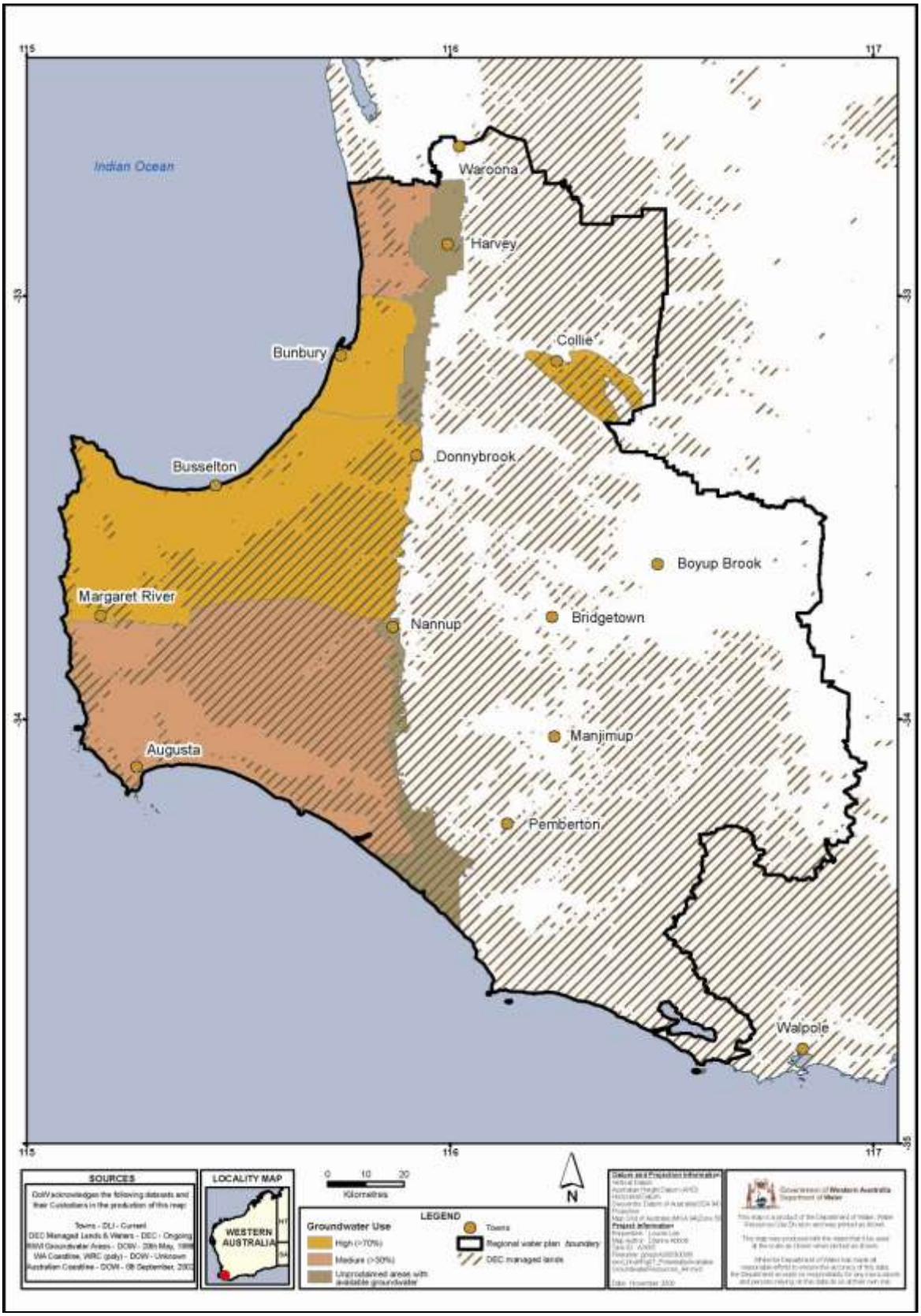


Figure 7 *Level of groundwater allocation relative to the allocation limit (averaged across all aquifers) (2008)*

In view of the substantial water demand projections for the region, careful management, best-practice, and efficient water-use will be required in all sectors.

Surface water resources

Assessment of the region's potentially available fresh surface-water resources considers four types of development, as listed in Table 6.

Table 6 *Assessment approach for surface water supply dams*

Type of development	Assessment
Small self-supply farm dams for irrigated agriculture	A precautionary (conservative) approach is used for the scientific assessment due to the limited information available. The risk to the environment is weighed against the economic benefit of the water-use.
Moderate to large dams for mining or industrial use	Assessment is required to determine the dam's sustainable diversion limit.
Bulk water supply dams for irrigation cooperatives	
Scheme supply dams for town water supply	

The Department of Water has revised the allocation limits and current levels of allocation for the surface water resources of the Upper Collie, Capel, Busselton Coast and Lower Blackwood surface water management areas (see *Whicher area surface water allocation plan* and the *Upper Collie water allocation plan* available on the Department of Water's website). Allocation limits have previously been set for the Harvey Basin surface water management area.

Figure 8 shows an assessment of the current level of allocation of the region's potentially available surface water resources as a percentage of the allocation limit.

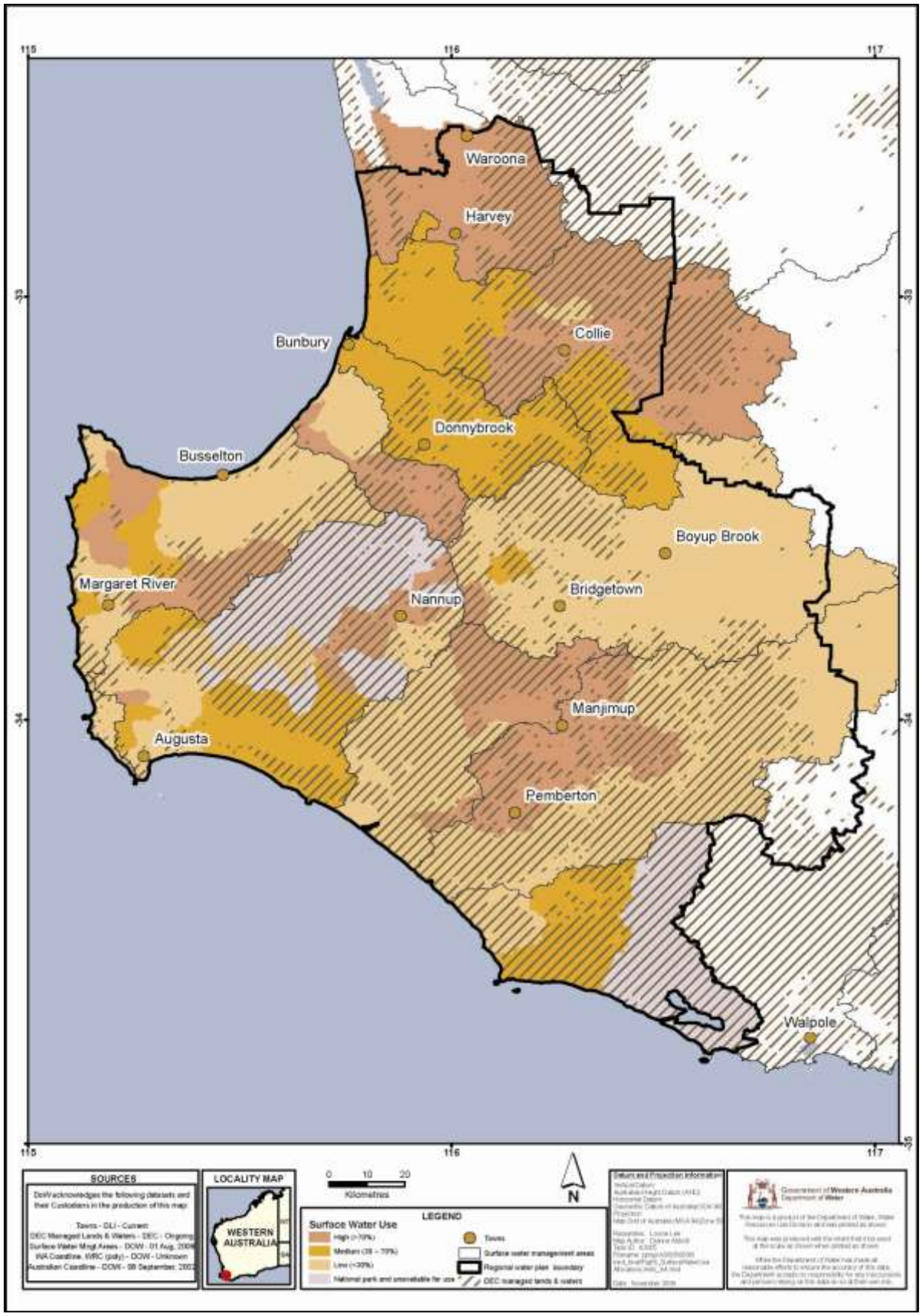


Figure 8 *Level of surface water allocation relative to the allocation limit (averaged across all catchments) (2008)*

In response to demand for water in the region's north, the Department of Water is currently reviewing the Brunswick, lower Collie and the Wellesley rivers, with allocation limits and an allocation plan due for completion in 2010. (The department is doing the same for the Warren-Donnelly surface water management area, also due for completion in 2010.)

One of the drivers for the review was the potential damming of the Brunswick River. The river was recently considered as an option for public water supply, however community feedback and the sustainability of the supply ruled it out as a future source (see Water Corporation's *Water Forever* document).

Significant issues of environmental impairment, source risk, water security and socio-economic impacts are associated with major dam developments, including competition with farmers for water. Additionally, while community consultation indicates strong support water-use efficiency, the use of surface water for public water supply was least supported.

The Water Corporation's sustainability assessment has rated the Brunswick dam option as low, followed only by the Kimberley pipeline and canal.

The Collie River is the other major river in the region. It has been substantially degraded and altered to support economic development in the region. The Department of Water believes that water-use efficiency measures in all sectors – including piping of open channels, increased water recycling and the use of alternative water supplies – present more sustainable options for the region than large-scale damming of surface water.

The region's remaining surface water management areas require a similar assessment to determine surface water allocation limits. For the purposes of this Plan, inventory estimates of potential water availability – based on National Land and Water Resources Audit (2000) demand and supply data – have been used. This involved assessments of appropriate types of surface water development (e.g. self-supply farm dams or public water supply dams) and a conservative estimate of the sustainable diversion amount.

More recent assessments are based on the 'standard period' rainfall of 1975–2003, which the Department of Water has adopted as the standard period for hydrologic determinations. It is acknowledged that the hydrology (including rainfall and streamflow) for this period is not representative of the long-term or pre-clearing hydrology. However, it is well documented that post-1975 a measurable decline in average rainfall has occurred in the South West of Western Australia, with a subsequent decline in streamflow. As a result, it is important that this period is used as the 'baseline' to ensure the rainfall and streamflow records used for current and future planning are not biased by a longer, wetter period.

As discussed previously, the drying climate is expected to impact considerably on surface water resources. This will present a significant challenge for any major works proposals for waterways, particularly in regard to maintaining the water balance (critical for the health of waterways). With an anticipated continued drying climate in

the South West, the longer-term security of surface water sources in the region cannot be guaranteed with any level of confidence.

The long-term drying climate scenario of up to 10 per cent less average rainfall by 2030, in combination with climate variability, could reduce streamflows and hence water availability by about 30 per cent. This would move a number of subareas to higher levels of allocation. The effects of changes in vegetation cover in a catchment will affect the quantity and/or quality of surface water and potentially groundwater.

Surface water/groundwater interactions

Recent hydrological and hydrogeological analyses indicate that many south west waterways have significant movement of water between groundwater and surface water for a significant part of the year, if not all of it. Unfortunately these interactions are not yet well understood on a regional level.

The lower Blackwood and Capel rivers are two examples of waterways where the movement of water between surface water and groundwater is significant and complex. Groundwater discharges into the lower Blackwood River and many of its tributaries including Poison Gully and Milyeannup, Layman, St Johns and Rosa brooks. Groundwater also discharges to the upper Margaret River and rivers on the coastal plains including the Scott River. Most summer flow in streams is maintained by groundwater baseflow.

The connectivity between surface water and groundwater is currently being investigated in several major rivers in the Plan area (Capel, Margaret and Blackwood rivers). As part of an investigation into the Cowaramup area, the department is building a regional appreciation of groundwater/surface water interactions, particularly along the Margaret River. The work is looking mainly at the potential for impacts on river systems as a result of an altered groundwater abstraction regime.

The *South West groundwater areas allocation plan* (Department of Water 2009a) outlines work planned to assess groundwater/surface water interactions.

Investigations will determine:

- where the large interactions are occurring
- processes by which the interactions occur
- the amount of water moving between these waterbodies
- dependencies of the aquatic ecology
- effects on the water quality.

Alternative water resources

Alternative water supplies such as recycled water, stormwater, greywater[11] and drainage water will become increasingly important in the region as demand for

[11] Greywater is wastewater from the kitchen, laundry and bathroom (but not the toilet).

groundwater and surface water resources becomes restricted by the available water (allocation limits). With appropriate treatment, these alternative water supplies are suitable for a range of purposes. These include irrigation for pasture and crops, public open spaces and recreational areas such as golf courses, and water for industrial processing – almost all non-potable uses.

Substantial use of recycled water and fit-for-purpose use of lower-grade water is already occurring, and this trend is likely to increase in the future. Some south west communities already use recycled water on tree lots, golf courses and sports ovals. Assessment of the potential for such resources to provide water for direct use, or to replace freshwater-use, particularly excess drainage water in the Harvey and Collie drainage districts, is required. The Department of Health (DoH) has produced draft *Alternative water supply guidelines for stormwater and rainwater*, available on the DoH website.

3.2 Projected water availability and demand per subregion

Currently about 820 000 ML/yr is potentially available for consumptive use in the region (220 000 ML/yr of groundwater and 600 000 ML/yr of surface water). Under a drying climate, available water could reduce to about 610 000 ML/yr by 2030, which is less than the region's moderate growth-demand projection of a total water allocation of approximately 710 000 ML/yr. Even with 20 per cent water-use efficiency gains in key sectors, demand would be about 570 000 ML/yr. Available water resources are often located far from where they are needed and meeting demand may be difficult (Figure 9).

Water demand and availability projections are presented for three south west subregions, based on the ABS statistical subdivisions of Preston, Vasse and Blackwood.

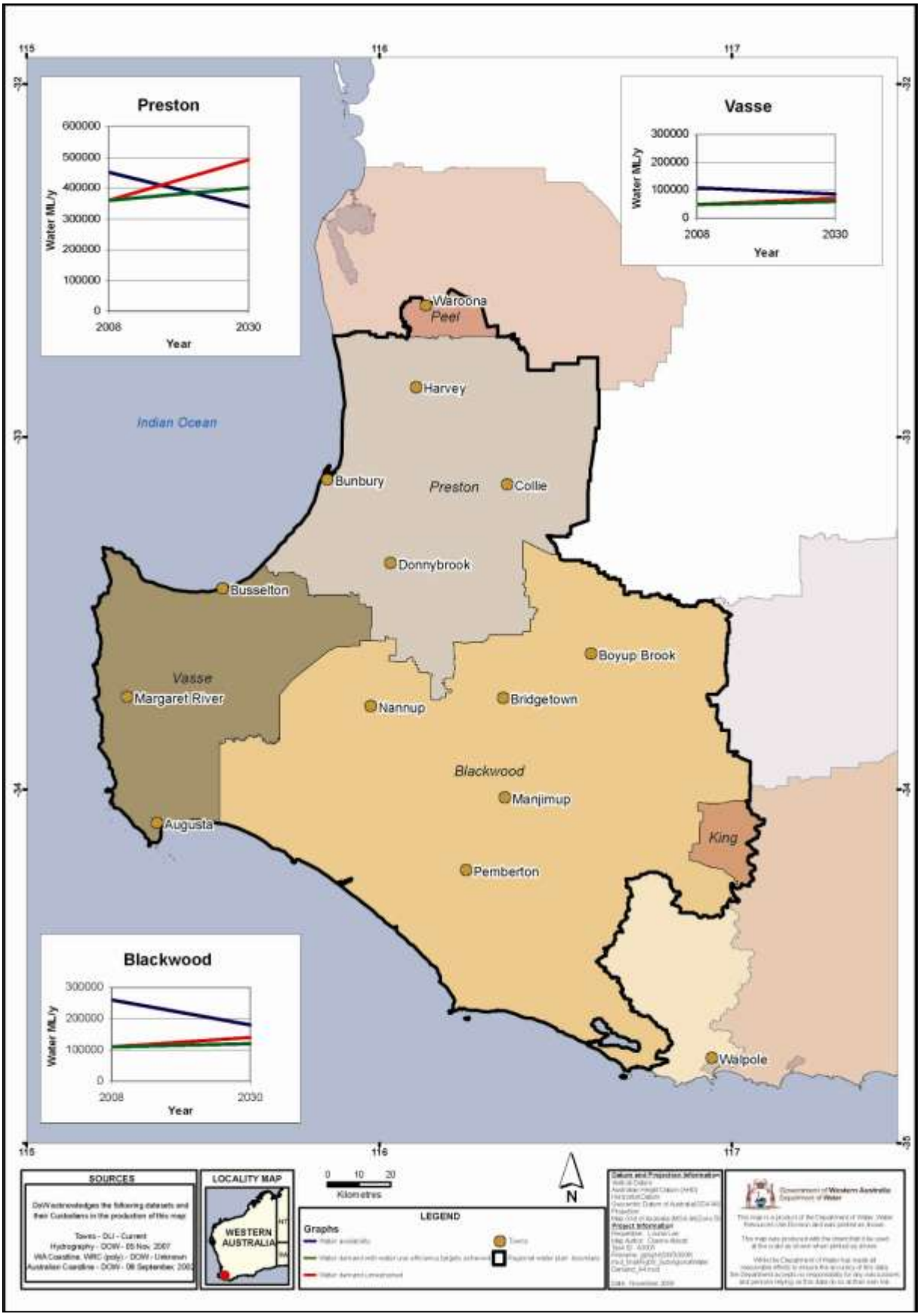


Figure 9 *Subregional water demand and availability*

Preston subregion

The Preston subregion **(**Waroona, Harvey, Bunbury, Dardanup, Collie, Capel and Donnybrook-Balingup local government areas), with an estimated current use of 360 000 ML/yr, represents about 70 per cent of the region's total water demand. This is due to a combination of large-scale irrigated agricultural use (supplied by Harvey Water), mining and industrial use in the Collie and Harvey local government areas, and the large population base of the greater Bunbury area.

The subregion's 450 000 ML/yr of potentially available water is already heavily used, but a drier climate could reduce water availability to about 340 000 ML/yr, which is below current estimated levels of use. Even under moderate growth assumptions, water demand is projected to increase to between 410 000 and 500 000 ML/yr by 2030, depending on the gains made by water-use efficiency measures. Thus demand growth in the subregion, particularly for irrigated agriculture, is likely to be heavily constrained (Figure 10). Further work is required to refine and address water demand and availability constraints in this subregion.

Increased access to alternative water resources, such as drainage water, stormwater and recycled water for fit-for-purpose use, will be an important consideration in the Preston subregion.

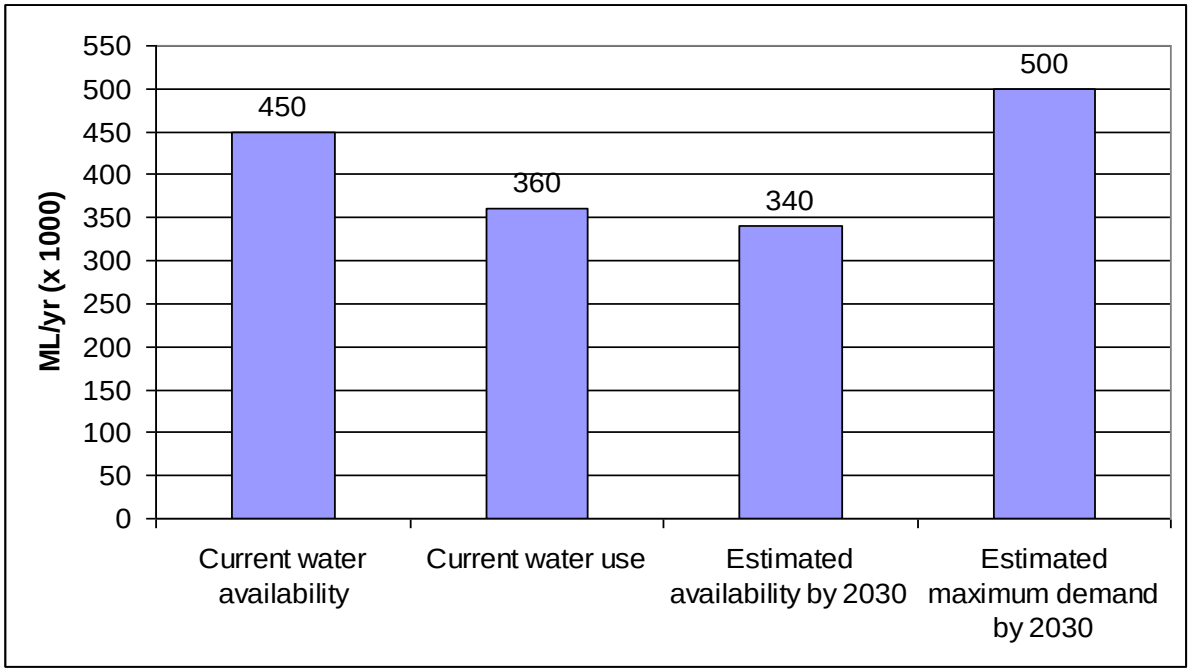


Figure 10 *Preston subregion: water availability and demand (2008)*

Vasse subregion

The Vasse subregion **(**Busselton and Augusta-Margaret River local government areas), with an estimated current use of 50 000 ML/yr, accounts for nearly 10 per cent of the region's total water-use. More than half of this is for self-supplied

agricultural use, with the remainder for mining/industrial and town water needs (Figure 11).

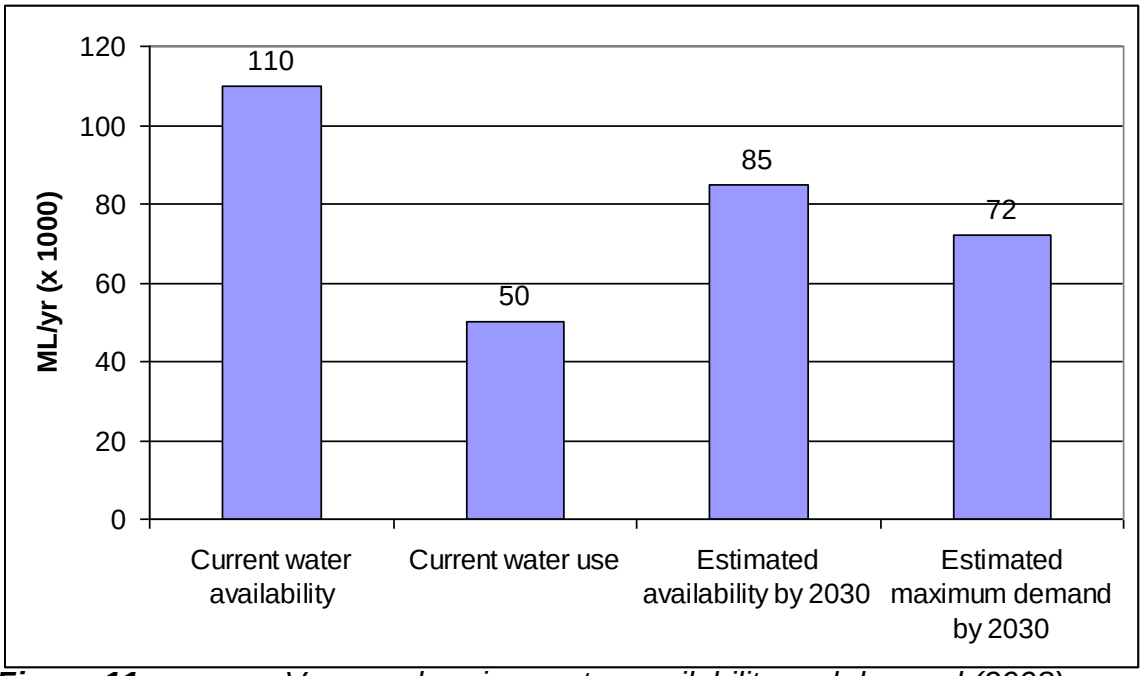


Figure 11 *Vasse subregion: water availability and demand (2008)*

Although the subregion's 110 000 ML/yr of potentially available water resources are, overall, at a medium level of use, a number of individual surface water and groundwater resources are at high levels of use (see figures 7 and 8). A drier climate is expected to reduce water availability to about 85 000 ML/yr, significantly increasing the number of highly allocated water resources.

Vasse water demands are projected to grow to between 59 000 and 72 000 ML/yr by 2030, depending on gains made by water-use efficiency measures. While the estimated water availability by 2030 appears to be able to satisfy the projected maximum demand, these gross figures do not necessarily reflect the situation in individual subareas.

Blackwood subregion

The Blackwood subregion **(**Bridgetown-Greenbushes, Boyup Brook, Manjimup and Nannup local government areas), with an estimated current use of 110 000 ML/yr, accounts for about 20 per cent of the region’s total water-use. About half of this goes to plantation interception of water and most of the remainder to irrigated agriculture.

The subregion's 260 000 ML/yr of potentially available water, mostly surface water, is expected to decline to about 185 000 ML/yr by 2030 under a drier climate

(Figure 12).

Water demand is projected to increase to between 125 000 and 140 000 ML/yr by 2030, depending on gains made by water-use efficiency measures. Most of the new demand will be for expansion of irrigated agriculture. While the estimated water

availability by 2030 appears to be able to satisfy the projected maximum demand, these gross figures do not necessarily reflect the situation in individual subareas.

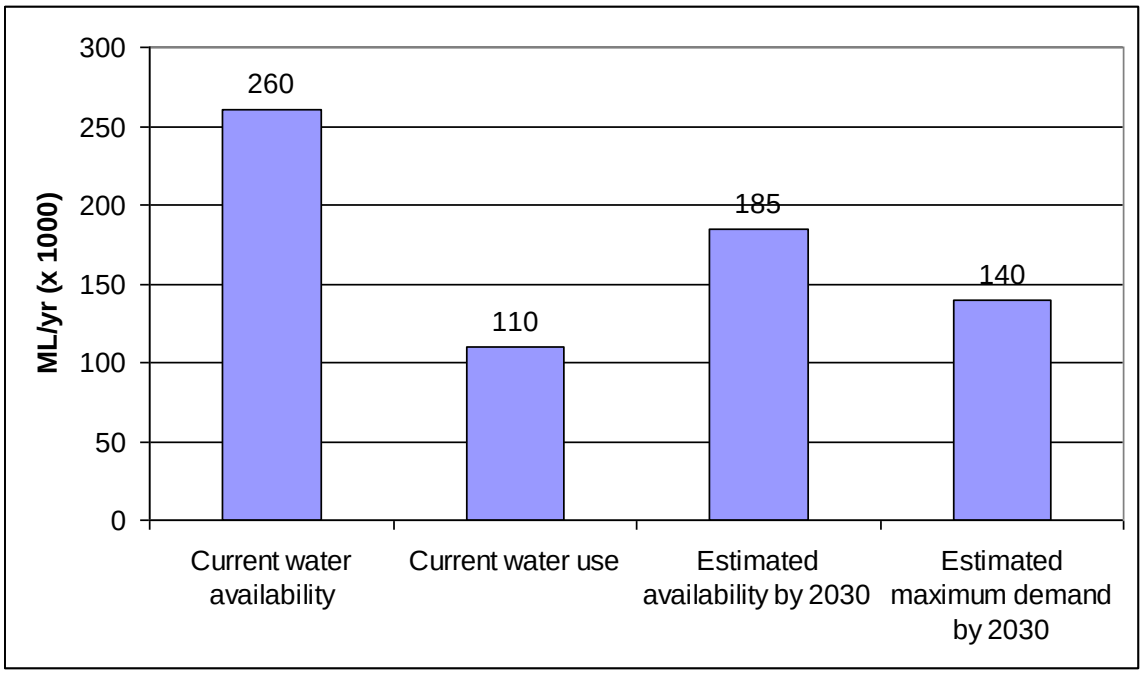


Figure 12 *Blackwood subregion: water availability and demand (2008)*

3.3 Current water demand

An area cannot continue to develop if water demand continues to exceed water supply from primary sources (e.g. groundwater and surface water) as well as alternative water sources (e.g. recycled water). In the south west, increases in demand for water supply are most likely to come from three sources: population growth, agriculture, and mining and mineral processing. In 2008 more than 60 per cent of the region's estimated current water demand (for both groundwater and surface water) was dominated by the irrigated agriculture, mining and industry sectors, as shown in Table 7. Large-scale plantation forestry is also a high 'user' of water through its ability to intercept significant volumes of rainfall and groundwater.

Table 7 *Estimated South West water demand by sector (2008)*

Use type	Total (ML/yr)	% of total
Irrigated agriculture	240 000	50
Plantation forestry	82 000	17
Mining and power generation	63 000	13
Industry and processing	44 000	9
Service industries/commercial	7500	2

Use type	Total (ML/yr)	% of total
Households	17 500	4
Private household bores	12 000	2
Public open space	11 000	2
Rural stock and domestic	5700	1
Total	**482 700**	**100**

100 000 litres (L) = 1000 kilolitres (kL) = 1.0 megalitre (ML) = 0.001 gigalitres (GL)

Not all of the water harvested in the south west is used to meet regional demand: several Water Corporation dams on the Darling Scarp supply water to the Integrated water supply scheme (IWSS) for the greater Perth region and the Goldfields. Water is also transferred from the Harris Dam to the Great Southern towns water supply scheme (GSTWSS). The water-use characteristics and demand projections for the major water-use sectors are outlined below.

3.4 Irrigated agriculture

Current water-use

There are important agricultural areas in the South West region on the Swan coastal plain between Cape Naturaliste and Cape Leeuwin, on the Scott coastal plain and in the Pemberton-Manjimup area. Changing economic conditions have resulted in fewer but larger farm dams and a gradual shift from grazing to horticultural crops.

Estimates of water-use for irrigated agriculture in the region are difficult due to poor availability of data, unlicensed surface water-use in some locations, and insufficient measurement of licensed water extraction. To improve estimates of land use and water demand, the Department of Water and Department of Agriculture and Food (DAFWA) have initiated a geographical information system (GIS) project to access digital information on land use and capability. In addition, the development of a water metering and measurement program in the region will improve water-use accounting.

Water-use for irrigated agriculture in the south west (both surface water and groundwater) is approximately 240 000 ML/yr. This estimate is based on the Australian Bureau of Statistics' agricultural census data on land use (ABS 2001) in conjunction with DAFWA's standard water-use 'crop factors' (Brennan 2007). More recent data from the GIS land-use project was used in preference to ABS 2001 data in the *Whicher area surface water allocation plan*, which is available on the Department of Water's website <www.water.wa.gov.au>.

About 45 per cent of the estimated 240 000 ML/y of water used for irrigated agriculture in the region is applied to relatively high-value horticulture and grape production. The remainder (55 per cent) is used for lower-value pasture production (Table 8). This is nearly double the state average of 23 per cent for pasture production, and in part reflects the region's lead role in the state's milk production.

Table 8 *Estimated irrigated agriculture water-use (2001)*

Agricultural use	Area (ha)	Water-use (ML/yr)	% water-use
Horticulture	7700	77 300	41
Grapes	5900	6400	4
Irrigated pastures	9800	103 000	55
Totals	**23 400**	**186 700**	**100**

Data source: ABS 2001

The main horticultural activities are vegetable growing (focused on Manjimup, Myalup and Busselton), fruit production (focused on Donnybrook and Manjimup) and nurseries (focused on Busselton).

Grape production is focused on the Augusta-Margaret River, Busselton and Manjimup shires, with most grown for wine making. Wine grape growers use less water and are generally water efficient. Water-use per hectare is about 10 per cent of that used to irrigate horticultural crops and pastures.

Pasture production for dairy and beef cattle is concentrated in the South West Irrigation Area (Waroona, Harvey and Collie irrigation districts) and Boyanup, and to a lesser extent around Manjimup and on the Scott coastal plain.

Nearly 40 per cent of water for irrigated agriculture in the region is from surface water provided by irrigation cooperatives through a piped scheme or irrigation channels. Most of this is supplied by the Harvey Water Irrigation Cooperative, which distributes water to the South West Irrigation Area from Water Corporation dams on the Darling Scarp. The much smaller Preston Valley Irrigation Cooperative provides water from the Glen Mervyn Dam to Preston Valley irrigators in the Donnybrook Shire.

To obtain water efficiency gains, the open channels are being progressively converted to piped water. This eliminates runoff drainage water that for nearly 100 years has provided summer backflow water to the waterways. Unfortunately this reduced baseflow in the waterways will have a significant effect on the ecology and water quality.

Self-supplied water from on-stream dams and direct pumping from watercourses accounts for more than 40 per cent of irrigated agriculture in the region, in areas such as Capel, Donnybrook, Busselton, Augusta-Margaret River, Manjimup and Pemberton. The remaining 20 per cent is provided from groundwater bores on the Swan coastal plain (from Harvey to Dunsborough) and the Scott coastal plain.

Projected water demand

Factors driving water demand for irrigated agriculture include the availability of good quality land, a suitable climate, adequate water supply and a market for the products. However, for many agricultural products it can be difficult to predict market forces over more than five years.

The total area of irrigated land in the south west has grown by about 12 per cent during the past 20 years: from about 21 000 ha in 1983 to about 23 400 ha in 2001.

This was driven by a threefold increase in land for horticulture and grape production, largely at the expense of irrigated pasture, which declined by 40 per cent. The overall effect of this was a 9 per cent reduction in water-use, due to the conversion of pasture to horticulture or grape production. Similar trends – for an overall increase in irrigated horticultural crops and a reduction in irrigated pasture – are predicted for the next 20 years.

This Plan recognises that opportunities to expand irrigated horticultural crops exist in areas such as Myalup, Harvey, the Scott coastal plain, Manjimup and the Leeuwin Ridge between Busselton and Augusta, subject to water availability. On the other hand, strong urban-growth pressures on the Swan coastal plain as well as the coastal strip from Waroona to Dunsborough will make it difficult to retain or expand irrigated agriculture in those areas. In addition, plantation forestry has grown rapidly in the past decade, competing for agricultural land in some areas.

It is expected that a drier climate will progressively reduce surface water and groundwater availability over the coming decades, which will ultimately constrain the irrigated agriculture sector's growth. Water scarcity will also drive significant improvements in water-use efficiency and the value of agricultural production per unit of water used.

There are practical limits to the availability of additional water for irrigated agriculture from scheme supply, self-supply groundwater and farm dams. Water sources for the Harvey and Waroona irrigation areas are fully allocated and no additional water is available. Although the Collie Irrigation District is currently under-utilising its water allocation, due mainly to poor water quality and demand constraints, there are options for increasing use, which include further development of irrigated agriculture. Additional groundwater is potentially available on the Swan coastal plain for irrigated agriculture, but this is constrained by competition from higher-value uses such as town water supply, industry and mining. Farm-dam irrigated agriculture could expand in a number of management areas, but some of these areas are at or approaching full allocation, which could trigger a trading market. In some management areas, plantation forestry may also compete for available water.

In terms of produce markets, trends for locally consumed food products (which are driven mainly by population growth) can be predicted reasonably well. The local component of the market would be expected to grow at 1 to 2 per cent per year.

The rapid growth in demand for irrigation water since 1990 has been driven by the growth in export markets, with 46 per cent of vegetables and 37 per cent of fruit (by value) exported. In recent years, however, produce markets have not been as promising, with significant price slumps in exported vegetable products and a depressed global wine market.

Future water demands for irrigated agriculture in the south west were examined by Brennan (2007), who provided upper and lower bound estimates within which the actual future demand is likely to fall. The lower bound scenario assumes that:

- export demand for horticulture only grows at the same rate as domestic demand growth

- grape production grows at 5 per cent per year
- pasture has zero growth in all areas with the exception of the Scott coastal plain.

The optimistic, upper bound scenario assumes:

- reasonably strong growth in export demand for horticulture (3 per cent to 4.5 per cent per year)
- grape production grows at 10 per cent per year
- pasture expands at less than 1 per cent per year in all areas except for the higher growth on the Scott coastal plain.

These assumptions produced a lower bound estimate of 242 000 ML/yr and an upper bound estimate of 467 000 ML/yr for demand in 2030; that is, between 30 000 and 260 000 ML/yr of additional water.

The Resource Economics Unit (REU) has recently (2009) provided the Department of Water with growth rates leading to an estimated demand of 370 000 ML/yr by 2031, which falls midway between Brennan's upper and lower bound estimates. REU's work is part of a larger project to provide water demand projections for all water sectors in 19 subregions across the state. The projections are based on results from the 'Monash' econometric model. This 'moderate growth' estimate would require an additional 130 000 ML/yr on Brennan's (2007) lower bound estimate by 2030.

It is highly unlikely that an additional 227 000 ML/yr will be available in the region to meet Brennan's (2007) upper bound estimate; moreover, taking into account likely reductions in water availability under a drying climate, it would also be difficult to meet REU's requirement of an additional 130 000 ML/yr by 2030 under the moderate growth projection.

There is a need for efficiency gains in irrigated agricultural production. An overall 20 per cent water-use efficiency gain would reduce the 2030 upper bound estimate to about 370 000 ML/yr or the moderate growth scenario to about 300 000 ML/yr.

3.5 Plantation forestry

Large-scale tree plantations are significant interceptors of water. They intercept rainfall and/or use deep roots to siphon groundwater. In areas such as the Collie catchment, tree plantations are used to improve water quality by reducing the mobilisation of salt. In other parts of the south west, private tree plantations have become popular, not for salinity management but as commercial ventures. This growth was driven by the popularity of managed investment schemes, although the financial crisis of 2009 has resulted in the failure of some of these schemes[12]. Plantations are also an option for farmers looking to move out of traditional agriculture or wanting to diversify their operations.

[12] Some of these schemes have now changed ownership in late 2009

Some people in the south west have voiced fears that more plantation forestry may reduce streamflows and lower watertables, leaving less water for other users and the environment. Large-scale plantation forestry can affect the amount of water available for other uses. Where a water resource is nearing or has reached its abstraction limit, the amount of water intercepted by a new plantation overlying the water resource needs to be taken into account in water allocation plans. The new water legislation will allow for the regulation of large-scale plantation forestry.

Current plantation water-use

The two primary types of tree plantations in the south west are:

- softwoods (such as radiata pine) – grown on rotations of 25–35 years
- hardwoods (such as Tasmanian blue gum) – grown on rotations of 8–12 years.

The total area of existing softwood plantations in the south west is approximately 55 000 ha (Forest Industries Federation of Western Australia 2007). Most pine plantations are owned and managed by the state government through the Forest Products Commission, although there are also large private holdings. Hardwood plantations have been established since the late 1980s, with approximately 70 000 ha planted in the region. Almost all of the hardwood plantations are privately owned, and industry growth has been driven largely by the capital accumulated by managed investment schemes (Forest Industries Federation of Western Australia 2007).

Most of the plantations established during past decade or so have been planted on cleared agricultural land. These areas are likely to have had higher groundwater levels and streamflows than in their pre-cleared native vegetation state due to lower evapotranspiration from agricultural land. The establishment of plantations tends to reverse this effect by the interception of rainfall, resulting in a decrease in runoff to waterways and groundwater recharge. The difference is undetectable where small plantations are planted or the annual rainfall is less than about 500 mm/yr, but becomes progressively more significant with large-scale plantations or where annual rainfall is above 600 mm/yr. Standard period rainfall (1975–2003) in the South West region ranges from 550 to 1100 mm/yr. Because plantations have greater leaf areas due to their closer and regulated planting densities, maturing plantation forests have higher evapotranspiration rates than mature native forests, intercepting more rainfall and transpiring more soil water than the latter. When pasture is converted to a hardwood tree plantation, groundwater levels near the plantation decline progressively for about four or five years – in some cases for up to 10 years – until they stabilise under a new water balance regime. These lower water levels then generally persist until the plantation is thinned or harvested.

About 50 000 ha of the region's plantation timber was established before the mid-1990s. Hence most of this will have already influenced the 1975–2003 'standard period' streamflows and can be considered part of the recent hydrologic baseline. Plantation timber established since the mid-1990s has been progressively reaching maturity and is starting to affect the 'standard period' streamflows. The estimated

effect of these plantings could be a total reduction in streamflows of approximately 80 000 ML/y. This is about 17 per cent of the south west's total water-use, a relatively large amount for a region experiencing growing competition for water against the background of a drying climate.

Most of the plantings to date have been spread out, with relatively low percentages of planted area to total catchment subarea. Analysis of land area covered by plantations within surface water management subareas shows that plantation forestry covers between less than 1 and 20 per cent of individual subareas, with only one subarea at 31 per cent. The situation is similar for the groundwater subareas. These are concentrated on the Blackwood River from Nannup to Boyup Brook, the Collie River East Branch, the upper Margaret River and Lake Muir. Most moderate-to-high levels of planting are in the lower-rainfall areas of the upper catchments and away from other water users such as irrigated agriculture. Most provide salinity-reduction benefits in the Collie, middle Blackwood and Warren catchments, except for the Scott coastal plain, Nannup and near Bridgetown (see Figure 13).

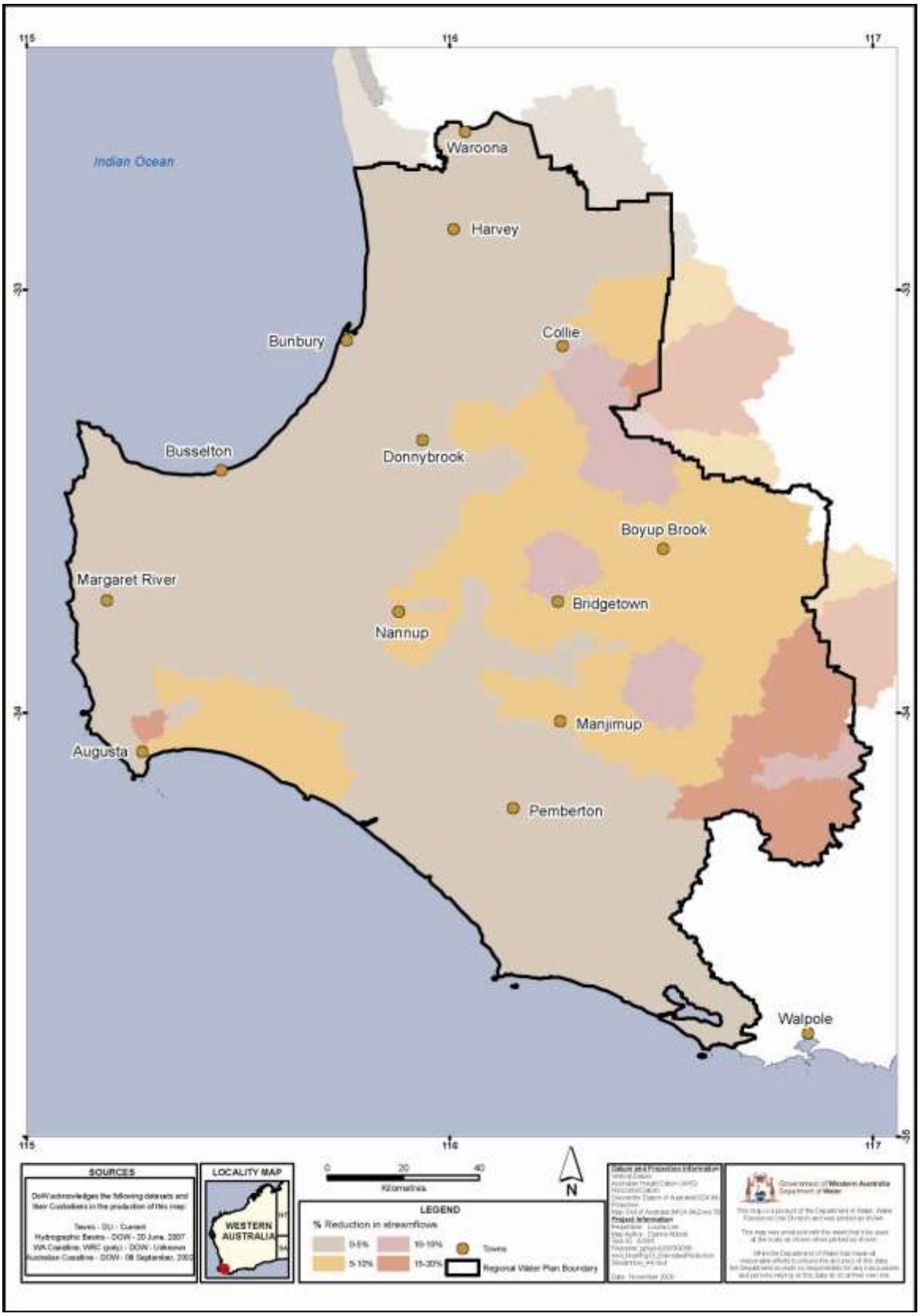


Figure 13 *Estimated reduction in streamflow caused by hardwood plantations*

Projected water demand

The late 1990s saw rapid growth in blue gum plantations in the south west, although this peaked by the year 2000 and has since stabilised at a much lower rate.

Information from the Bureau of Rural Sciences (2006) and the plantation industry indicates that further expansion in the region is likely to be limited due to the scarcity and relatively high cost of land, particularly in the higher-rainfall areas west of the Darling Scarp. It is expected that expansion will be focused more on the southern-most areas of the state such as the Albany and Esperance coast, Denmark River and Kent River. Modest expansion in the south west is likely to continue until about 2020, with total additional plantings of between 10 and 20 per cent of 2005 hardwood levels. A 15 per cent expansion would reduce streamflows in the region by about 10 000 ML/yr, bringing the total estimated reduction by plantations to about 92 000 ML/yr by 2030. The regions of main interest to the Department of Water are the Swan and Scott coastal plains.

In addition, there is potential for a significant increase in the rate of plantation expansion if carbon credit rules favourable to plantation forestry were introduced. Such carbon credits, in combination with sawlog, bioenergy and water quality benefits, would have a large bearing on the economics that would drive further expansion. The carbon credit rules in relation to plantations are still to be determined, however, the industry has indicated that the carbon credit price (in 2009) would have to reach about $150/tonne to make carbon sequestration viable in the high-value agricultural areas. On the other hand, plantings for carbon sequestration in the lower rainfall, marginal land areas might be viable at about $25/tonne.

3.6 Mining and industry

In terms of gross regional product, mineral extraction and processing is the leading economic sector in the south west. Mineral sands mining occurs in coastal areas (Busselton-Capel), with bauxite and coal mined inland. Coal-based power generation and alumina production are continuing to expand, while heavy mineral sands production is relatively stable. Coal mining and electric power generation are major users of groundwater in the Collie area. Groundwater abstraction in the Collie Basin has generally exceeded the volume of water entering the groundwater system from recharge. This dewatering of groundwater is necessary for mine safety and to allow mining of the coal to take place.

The power generation, coal, bauxite and mineral sands mining and processing sectors in the Collie, Harvey and Bunbury areas use about 107 000 ML/yr for dust suppression, slurry transfer, cooling, condensers, mineral separation, wash down and a range of refinery-based processing. The estimated 107 000 ML used each year comes from self-supply groundwater/mine dewatering (60 per cent) and surface water (15 per cent). The remaining 25 per cent comes from closed-site water capture and recycling.

Water demand from the mining and industry sectors in the south west is projected to grow by about 2 per cent per year to 2015, and then remain relatively steady to 2030, resulting in future water demand of about 140 000 ML/yr.

While many mining and industry users are reasonably efficient in the use and recycling of water, there is still room for improvement, particularly in the Collie Basin. On a regional basis, the efficiency target for projected future water-use for the mining and industry sectors is 20 per cent by 2012.

3.7 Town water supply

Population growth

The population of the south west in 2006 was approximately 138 000 (ABS 2006). Population growth and its associated economic development will place increasing demand on the region's water resources, particularly in the coastal areas where most of the growth is expected. In the period 2001–06, the region's population grew by an average of 1.8 per cent per year (ABS 2006). The greatest proportion of the population is concentrated in the greater Bunbury area, the Bunbury to Busselton coastal areas and the Shire of Augusta-Margaret River. Based on Western Australian Planning Commission (WAPC) (2005) projections, the region will be home to an estimated 153 000 people by 2011, 175 000 by 2021 and 193 000 by 2031.

Despite water conservation efforts, increases in population will increase the demand for public water supply. Some communities, such as Margaret River, are nearing the limits of their current public water supplies and will need to find additional resources in the near future (see Section 7).

Current water-use

Town water supply needs in the south west are supplied by the Water Corporation, Aqwest and Busselton Water. Groundwater, sourced primarily from the Swan coastal plain and the Cape to Cape area by Aqwest and Busselton Water, provides up to 80 per cent of total town water supplies. The Water Corporation draws its water from a number of surface water and groundwater sources. The inland towns east of Nannup rely on surface water because there is little reliable groundwater in the fractured rock aquifer environment.

The region's towns have historically used adjacent water sources to meet their needs. The availability of such supplies diminished the need for water to be transferred over large distances. As water supplies decrease, these towns are now being linked to local area networks to produce small integrated water supply networks. An example of this is the Balingup, Greenbushes and Bridgetown integrated water supply system.

For most towns, about 70 per cent of the water is used domestically, the remainder being used for commercial and services needs. Water-use in the tourism sector is considered to be commercial use for water accounting purposes.

Projected water demand

Based on WAPC (2005) population projections, at current levels of per-capita use, total demand for town water supplies in the region is projected to increase by about 10 000 ML/yr, or nearly 40 per cent, by 2031 (Brennan 2007). The population growth rate is, however, likely to slow after 2015, in line with demographic projections for the state as a whole. In some south west towns, it is possible the tourism sector will grow faster than the residential sector, which would increase the projected town water supply needs for these areas – particularly during the summer tourism season. It should be noted that both the Water Corporation and Busselton Water expect the growth rate in some towns to be greater than WAPC's 2005 projections.

Current domestic per capita water-use varies widely in the south west, from a little over 100 kL/person/yr for some inland towns to more than 200 kL/person/yr for some coastal towns. By comparison, Perth domestic water-use is about 106 kL/person/yr, indicating there is scope for efficiency gains in the region. A target household water-use efficiency gain of 10 per cent by 2015 and 20 per cent by 2030 is feasible, and would help to contain future water needs in a drying climate to about 4000 ML/yr.

The Department of Water has reserved more than 13 000 ML/yr of water for public water supply in the *South West groundwater areas allocation plan* (DoW 2009a). Service providers will need to submit water source development plans to gain access to the water reserved for public water supply. This will include the submission of a water efficiency management plan to demonstrate efficient use of existing water sources, as well as a plan for investigation and development of proposed sources.

By 2021, the greater Perth area (i.e. metropolitan Perth, Mandurah and Murray) will be home to an estimated two million people. The additional population will increase the demand for public water supply in that region. Water resources in the south west may be used to meet some of that demand, with one possible source being Wellington Dam near Collie.

4 Wise water-use

Refer to the actions identified in the Strategic directions and actions *document under Theme 6: Use water efficiently.*

4.1 Efficient domestic water-use

Table 9 shows the average annual consumption of scheme water in the south west. In 2008–09, the average Perth household used 268 kL/yr of scheme water[13], while in the same period more than half the south west towns used more scheme water per residence. It should be noted that south west localities support significant holiday or visitor demands for water and do not have access to groundwater for domestic bores.

Table 9 *Residential consumption rates in the south west (2008–09)*

Water service provider	Area supplied	No. of residential connections	Average annual consumption (kL/connection)
Busselton Water	Busselton	9344	305
Aqwest	Bunbury	14 986	280
Water Corporation:	total	29 760	255
	Dalyellup	1799	490
	Australind-Eaton	8544	385
	Dunsborough-Yallingup	2984	343
	Capel	663	323
	Peppermint Grove Beach	293	323
	Donnybrook	873	308
	Yarloop	234	306
	Boyanup	314	303
	Brunswick, Roelands, Burekup	662	300
	Collie	3178	300
	Harvey/Wokalup	1163	296
	Dardanup	160	273
	Margaret River scheme	2809	264
	Manjimup	1798	216
	Binningup	586	213
	Nannup	218	212
	Bridgetown-Hester	1125	206
	Boyup Brook	342	199
	Pemberton	332	190

[13] Stage 4 water restrictions were introduced in Perth in 2004

Water service provider	Area supplied	No. of residential connections	Average annual consumption (kL/connection)
	Augusta	834	190
	Dwellingup	231	188
	Myalup	145	181
	Preston Beach	321	161
	Northcliffe	69	123
	Quinninup	83	94

The Water Corporation is working towards a 2012 residential-use target of 100 kL/person/yr of scheme water for the Perth region. This target will be extended to the South West region to be met by 2020. In 2006 Perth consumption of scheme water averaged 106 kL/person/yr.

In May 2007 the state government introduced the *Water Use in Houses Code* as part of its 5 Star Plus program, which includes a water efficiency labelling scheme (WELS) that requires certain products to be registered and labelled with their water efficiency in accordance with the standard set under the *Water Efficiency Labelling and Standards Act 2005* (Cwlth). The new building code applies to all new houses approved for construction after 1 September 2007. The 5 Star Plus measures have the potential to reduce water consumption in an average home by 100–140 kL/yr.

4.2 Efficient water-use in local government

Water conservation plans are a way for local governments to commit to water-use efficiency improvements in irrigating their public open spaces. Water conservation measures may include more water efficient sprinkler heads, soil moisture sensors, water filters and new water regimes that include the use of flow meters and hydrozoning[14]. Such measures can still produce good turf to satisfy sports groups and other recreational users.

ICLEI Water Campaign™

In 2003 the *International Council for Local Environmental Initiatives* (ICLEI) launched a voluntary program to build the capacity of local governments to reduce water consumption and achieve tangible improvements in local water quality and environmental conditions. All local governments are encouraged to join the ICLEI Water Campaign™. In the south west, the program receives funding from the state government and South West Catchments Council (SWCC). Participating local governments are the shires of Capel, Augusta-Margaret River, Collie, Harvey and Waroona and the City of Bunbury.

[14] Setting different water regimes for sections of public open space appropriate to water-use

The program helps councils to:

- determine what they can control within their own operations
- understand what they can influence in the community through land-use planning, regulation and education
- work with other councils and interest groups in the catchment to achieve long-term improvements in water quality.

Waterwise Councils program

The *Waterwise Councils* program is a joint initiative between the Water Corporation and the Department of Water. It is part of the ICLEI Water Campaign™. The program's aim is to build a cooperative working relationship with local governments to promote sound water management and improve water-use efficiency within their operations as well as in their communities. It encourages people to use products and services that are designed to maximise efficient water usage, from the use of groundwater resources for public open spaces through to water-use in offices.

To join the program, councils need to meet several criteria for use of both scheme water and groundwater/surface water. They need to complete an inventory of water-use in council buildings and public open spaces, develop a water conservation plan and conduct a water audit of businesses in their jurisdiction. Councils also need to implement staff training in and projects on water-use efficiency. The program sets councils on a path of continuous improvement, with the Department of Water guiding them through the water conservation planning process for groundwater-use, and the Water Corporation doing the same for scheme water-use. Program members in the south west are:

- Augusta-Margaret River Shire
- Manjimup Shire
- Boyup Brook Shire
- Bridgetown-Greenbushes Shire
- Waroona Shire
- Shire of Murray
- Harvey Shire
- City of Bunbury
- Dardanup Shire
- Collie Shire
- Capel Shire
- Busselton Shire
- Donnybrook-Balingup Shire
- Nannup Shire.

4.3 Efficient water-use in irrigated agriculture

Increasingly, farmers are expected to use water efficiently and effectively. The Department of Agriculture and Food (DAFWA), in partnership with natural resource management (NRM) groups, the agricultural sector and other government agencies, has promoted water-use efficiency through training programs, information and special events such as the Harvey Water Irrigation Expo.

The *Waterwise on the Farm* program is a multi-stakeholder industry initiative developed and delivered by DAFWA and the Perth Region NRM's *Sustainable Production Program* and covers the South West region. The program's objective is to provide training courses on techniques and strategies for efficient irrigation and nutrient management practices through demonstration sites, community/industry awareness, and specialist support. More than 210 south west irrigators have attended workshops during the past three years. The program also supports irrigators in preparing irrigation management plans.

Harvey Water piping project

Harvey Water traditionally supplied irrigation water to its customers via an open channel system. About 30 per cent of the water was lost before it reached the farm, mainly through seepage. In 2003 Harvey Water completed conversion of the Waroona Irrigation District to a gravity-fed piped system, reducing water loss to 2 per cent or less and saving 10 000 ML of water each year. The 250 km pressurised piped system delivers irrigation water to more than 300 irrigators throughout the Harvey Irrigation District.

Harvey Water completed the piping project with a permanent trade of 17 100 ML/yr in water savings to the Water Corporation for the Integrated water supply scheme (IWSS). The project sourced water from Stirling Dam (5800 ML/yr), Samson Brook Dam (6000 ML/yr) and Logue Brook Dam (5300 ML/yr). Currently there are plans to convert the Collie Irrigation District to a piped system.

The piping of the open channels has not been completely risk free. The piping has reduced groundwater baseflow to waterways, as well as groundwater recharge, thereby potentially increasing water quality problems and placing waterway ecology at risk.

The marginal salinity status of irrigation water from Wellington Dam limits the types of crops that can be grown in the district. If Wellington Dam attained fresh status, it might stimulate a partial shift from irrigated pasture to higher-value, but less salt-tolerant crops such as grapes. The ability to grow higher-value crops would make conversion to a piped system more economically feasible. A piped system would reduce the amount of water lost to leakage and enable irrigators to use more water efficient technology (e.g. central-pivot systems). In the longer term, this would reduce demand for irrigation water from Wellington Dam and thereby make more water available for other uses. Harvey Water will be funding DAFWA at the Harvey Agricultural College to compare five different irrigation systems.

4.4 Use of non-potable and recycled water

Many consumptive uses do not require potable water (i.e. water fit for human consumption). The use of non-potable water on a fit-for-purpose basis is an effective mechanism for reducing the pressure on depleting freshwater resources. Wastewater re-use and the use of non-potable water sources for complementary purposes, such as greywater for gardens, illustrate the fit-for-purpose concept.

As a result of the salinity recovery process in the Collie catchment, the concept of fit-for-purpose water has been introduced in the Upper *Collie water allocation plan.* Additionally, the Department of Water is investigating the concept of a water service provider to ultimately collect, manage, treat and distribute or sell fit-for-purpose water to local and regional industry.

Minerals and energy sector

The minerals and energy sector has sought to use non-potable water sources that would otherwise require substantial treatment to reach potable standard. Further scope for improvement exists in the Collie catchment (Collie-Wellington Basin Water Source Options Steering Committee 2007). Approximately 90 per cent of the water drawn by the sector from state-owned dams comes from non-potable groundwater and surface water sources (e.g. water with elevated salinity). Parts of the mineral sands sector are using marginally saline water. Another example is the alumina sector, which is re-using nutrient-laden runoff in preference to high-quality water.

Currently in the south west, the minerals and energy sector meets about 25 per cent of its water needs through closed-site water capture and recycling. Additional efficiency gains may be feasible through best-management practices. Electricity generation stations in Collie rely largely on water removed from mining operations as cooling water in their plants. Dewatering should be considered a temporary activity until coal mining is no longer economically viable.

Old mine voids provide a different type of re-use opportunity. The mine voids created by open cut mining have the potential to become recreational lakes. In the Collie area, several mine voids are undergoing transformation into significant public recreation assets (i.e. Stockton Lake). The Western 5H mine void is part of a project to test the viability of using mine lakes for commercial aquaculture.

Recycled water

The collection, treatment, disposal or re-use of wastewater (or sewerage) is an integral part of the water management cycle. At wastewater treatment plants (WWTPs), the water undergoes a series of processes that remove pollutant materials such as solids, oils and greases, detergents, nutrients, heavy metals and bacteria. The end products are recycled water and biosolids. In the longer term, recycled water is an option that needs to be further explored as an alternative water supply option for drinking water in the region.

Opportunities for re-use of recycled water from WWTPs include:

- watering of parks, ovals and golf courses
- agricultural and horticultural irrigation; for example, turf farms, tree plantations and market gardens
- industrial use
- recharging groundwater
- provision of a 'second class' of water to population centres through implementation of a dual-reticulation or third-pipe system [15]
- injection at the coastline into aquifers discharging into the ocean to create a mound where saltwater intrusions are occurring. (This will bank up the outward-flowing formations behind the mound, protecting the fresh water from saline intrusion. For example, the Yarragadee aquifer at Bunbury has significant saline intrusions because of abstraction.)

As of 2007, 10 of the Water Corporation's 26 wastewater treatment plants (WWTPs) in the south west delivered a re-use component, with effluent used on golf courses, tree lots and plantations. The cost of treating and distributing recycled water from WWTPs is often very high when compared with other sources of water. Despite interest from land developers and others, until now most re-use of water from WWTPs has occurred close to the facilities. As demand for water supply from third-pipe systems in residential or industrial developments grows, there is potential for broader application of recycled water, provided existing barriers can be overcome. Current constraints include high regulatory requirements, a lack of infrastructure and pricing policies.

The Department of Health (DoH) has an important role in water recycling, including the approval and monitoring of WWTPs and determining sewerage infill priorities. DoH's *Guidelines for the use of recycled water in Western Australia* (2000) are designed to bring the state's recycled water practices and schemes in line with national guidelines. The overall objective is to maximise the re-use of recycled water through minimising and managing any risks associated with its use. The guidelines are available on DoH's website.

4.5 Water trading

A key improvement in water resource management will be the ability to facilitate economic growth in fully allocated water systems. This does not mean allocating more water. It means re-allocating water (that has already been allocated) to higher economic uses on the expectation that once an economic value is placed on water, it will be used more efficiently. This is the basis for water trading, which is a market-driven but voluntary process.

[15] Third-pipe systems provide a non-potable water service through a piped system completely separate from potable water-supply piping.

The Department of Water's *Statewide policy no. 6: Transferable (tradeable) water entitlements for Western Australia* (2006) sets out a consistent and comprehensive policy foundation for the implementation of water trading in Western Australia.

As water trading occurs within the allocation limit of a particular water resource, it does not impact on the environmental water provisions. However, with groundwater trading, any potential environmental impacts of increased abstraction at specific drawpoints would need to be investigated before the trade was approved.

Statewide policy no. 6 contains the principles and rules for trading and addresses some of the more contentious issues such as discouraging the use of trading as a speculative investment. Water trading is expected to provide a number of benefits, such as:

- water allocated for consumptive use can move to higher-economic-value uses
- as water-use becomes more efficient, the options for trading surplus water increase
- more efficient water users have the opportunity to generate higher economic returns
- there is potential to reduce environmental risks and impacts
- there can be improved business flexibility for water users
- opportunities can be created for new users to obtain a water allocation, or for existing users to expand their businesses in fully allocated systems.

Water trading can be a viable option for access to water as water systems reach full allocation. Statewide policy no. 6 will be reviewed in the future to comply with the new water legislation. As water allocation plans are developed, they will set out the local trading rules for particular water resources in line with the new policy. Trading registers will provide the public with information about water trades in a transparent and timely manner. Details on how the trade will operate will be defined in water allocation plans.

4.6 Metering water extraction

The metering of water extraction is a key water reform initiative for Western Australia. To effectively manage the south west's water resources, the Department of Water will expand requirements for accurately measuring the volume of surface water and/or groundwater taken for use by:

- arranging for the installation of government-owned flow meters at all drawpoints covered under licences granted under the *Rights in Water and Irrigation Act 1914*, in areas where demand for water is high, and
- imposing metering requirements on certain water licences in areas where government-owned meters are not being installed.

The department has prepared the following documents to guide and administer metering across the state:

- Rights in Water and Irrigation (Approved Meters) Order 2009

- *Strategic policy 5.03 – Metering the taking of water* (DoW 2009)
- *Guidelines for water meter installation* (DoW 2009).

Metering is an effective tool to:

- improve water-use efficiency and the business performance of water users
- manage specific risks to ecological water requirements, water quality and impacts on other water users
- avoid conflict over water-use
- provide a more secure water access entitlement (WAE) system and an effective water trading market
- better inform water allocation and licensing decisions.

In some parts of the region, water extraction is already metered, which has generally been restricted to licensees with large water allocations such as mining companies and water service providers that extract more than 500 ML/yr.

In the absence of metering, resource managers must rely on labour-intensive water-use surveys or simply estimate actual water extraction from the amount of licensed allocation. This can result in significant underestimations or overestimations of actual extraction. As part of the water reform process, the Department of Water has initiated a statewide metering program which is progressively expanding metering requirements to include all existing and new licensed water users with an annual allocation of 50 ML/yr or greater.

This will result in about 93 per cent of water extraction being metered. Increased metering will lead to improved knowledge about the region's water resources and greater capacity to manage them effectively. While less than 8 per cent of all groundwater licences currently include a metering requirement, this accounts for 78 per cent of the allocated groundwater. By comparison, approximately 10 per cent of surface water licences have metering conditions.

Metering of water provided by water service providers is undertaken in accordance with their service provision agreements.

4.7 Water quality best-management practices

Best-management practices are becoming increasingly significant in water quality management with respect to both point-source and non-point-source contamination; but they do present some management challenges. Without evaluation, it is often unclear whether participation in best-management practices actually translates to better practice. Programs such as the Water Corporation's Busselton Environmental Improvement Initiative have demonstrated that it can be difficult to achieve voluntary adoption, even when incentives are offered (O'Grady & Humphries 2003).

Under the *Rights in Water and Irrigation Act 1914*, water users are responsible for the quality of water leaving their property in proclaimed areas and where a licence to take water is required. Through this process, the Department of Water assesses the

risk of waste or discharge water to receiving waterbodies and if deemed necessary, water quality monitoring may be required as a licence condition. The department produces water quality protection notes to inform the wider industry and community about the requirements and best practice. In addition, local government authorities, through their planning process, may require documentation to assess pollution management, such as effluent management plans.

All surface water runoff and groundwater leaching into the drainage systems of the south west has the potential to impact on water quality. The magnitude of the impact depends on many factors including the type of land use. For example, the main water quality issue in the upper Blackwood catchment is salinity, whereas water-soluble phosphorus entering waterways and wetlands is one of the single biggest factors affecting the long-term environmental health and amenity of coastal waterways.

In September 2006 the Minister for the Environment announced the state government's intention to replace the use of highly-water-soluble phosphorus fertilisers with low-water-soluble phosphorus fertilisers within environmentally sensitive areas of the south west, including the Scott coastal plain and the Peel-Harvey, Leschenault and Vasse-Wonnerup estuarine systems. In 2007 a Joint Government and Fertiliser Industry Working Party (2007) released a draft fertiliser action plan for the Peel-Harvey Estuary. Whether this is extended to the Leschenault and Vasse-Wonnerup estuaries in the future depends on trials and funding.

5 Water resource allocation planning

Refer to the actions identified in the Strategic directions and actions *document under Theme 2: Enhance the security of water resources for the environment and users.*

The Department of Water is responsible for water allocation planning through:

- proclamation of groundwater and surface water areas
- licensing water extraction
- preparation and implementation of water allocation plans, in accordance with the *Rights in Water and Irrigation Act 1914*.

Water allocation plans provide the fundamental basis for the equitable sharing of available water between competing uses.

5.1 Objectives

The objectives of water resource allocation planning are to:

- define the condition of water resources
- define water availability
- protect the long-term security of water resources and their prioritised beneficial uses
- ensure water resources are used efficiently and within allocation limits and avoid over-allocation that can lead to over-use
- equitably share water resources between competing beneficial uses and the environment
- maximise the economic benefit to the state within the limits of acceptable social and environmental consequences.

The Department of Water acknowledges that water requirements for the environment must be adaptable to changing climate conditions. The department accounts for climate factors in developing allocation limits and management strategies for a given water resource, including allowing for sufficient buffering capacity within the allocation limit for a decline in recharge or runoff. The current allocation systems have a built-in hierarchy proportioning the water resources between what remains in situ (meeting ecological, social and cultural needs) and water that can be allocated for consumptive use. This process is detailed in water allocation plans.

5.2 Water allocation plans

Water allocation plans determine how much water should remain in the groundwater resource or watercourse for the environment and how much water should be shared among water users for various consumptive uses.

Allocation plans may focus on either groundwater or surface water resources, or address both in the same plan. While surface water and groundwater are generally

managed separately, a key issue for the Department of Water is to ensure that when managing connected water systems, the water resources are not allocated more than once.

Plans identify the water resources and water regimes to be protected. They guide the department's licensing of the take and use of water for commercial purposes such as irrigation, industrial use and mining and the servicing of rural and urban communities.

Before 2007, only the Bunbury, Busselton-Capel and South West Coastal groundwater areas and the Harvey surface water management area had water allocation plans in place.

Existing or new non-statutory allocation plans will remain in effect until they are replaced by a statutory water allocation plan developed under the provisions of the *Rights in Water and Irrigation Act 1914* or the new water resources management legislation. Statutory plans have greater legal effect than non-statutory plans. The current (October 2009) priority areas for water allocation planning are listed in Table 10.

Table 10 *Priority areas in the South West for water allocation planning*

Priority area	Allocation plan
South West groundwater areas (includes proclaimed Bunbury, Busselton-Capel and Blackwood groundwater areas, and parts of the South West Coastal groundwater areas)	The *South West groundwater areas allocation plan* examines the demands on resources and their ability to meet consumptive uses in an environmentally sustainable manner. This non-statutory plan lays the foundation for development of a more in-depth statutory plan for these resources.
Kemerton groundwater subareas	Part of the South West groundwater areas is also managed by the *Kemerton groundwater subareas: water management plan,* which provides the policies and rules for the Kemerton Industrial Park and surrounding area.
Whicher subregion – surface water resources	The *Whicher area surface water allocation plan* covers the Cape to Cape subregion, which has experienced reduced rainfall and significant growth in the number of private on-stream self-supply dams. This will be the first management plan for surface water resources in this subregion. This non-statutory plan lays the foundation for development of a more in-depth statutory plan for these resources.
Upper Collie groundwater and surface water resources	Water resources in the upper Collie have supplied the local power industry, mining industry, public water suppliers and irrigators for many decades. Demands are increasing as new power stations and industries are proposed for the region. The *Upper Collie water allocation plan* provides the basis for allocating water from the upper Collie water resources under the existing supply and demand scenario. This non-statutory allocation plan will be followed by development of a statutory allocation plan.
Lower Collie groundwater and surface water resources (including the	The *Lower Collie water allocation plan* is being developed to address the following issues:

Priority area	Allocation plan
catchments of the lower Collie River, Brunswick River and their tributaries)	• the lack of allocation objectives to guide strategic allocation decisions • interest and proposals to dam the Brunswick River • understanding and managing potential hydrological impacts from piping the irrigation network while improving water efficiency • uncertainty over the components of the water balance, especially for irrigation return-flows • managing increased self-supply demand • increased demand and interest in the water resources from regional industries • protecting the river and estuary environments.
Warren-Donnelly surface water resources	The plan for the Warren-Donnelly surface water resources will include the Pemberton and Manjimup priority agricultural area. Agricultural production is undergoing transition, and significant growth in private tree plantations has occurred. The upper Lefroy Brook catchment has been significantly affected by reduced rainfall, and there has been some conflict over on-stream water storages and their impact on downstream flows and uses. This non-statutory allocation plan will be followed by development of a statutory allocation plan.

Water management areas

For the purposes of water resource allocation planning, the water resources of the south west have been assigned to groundwater areas and surface water management areas. Active management of water licences and entitlements is undertaken in proclaimed groundwater areas and surface water management areas.

Proclamation

For the Department of Water to allocate water resources and actively license water extraction, water management areas must be proclaimed under the *Rights in Water and Irrigation Act 1914*. Proclamation enables licensing of water extraction and facilitates upgrading of management practices. Most groundwater areas, irrigation districts (Waroona, Harvey and Collie) and public water supply areas are proclaimed. The department does not actively manage those areas that remain unproclaimed.

During the past 20 years, some unproclaimed surface water management areas have experienced significant growth, dramatic increases in water demand and reduced rainfall. The Cape to Cape subregion, for example, has seen a large increase in the number of private on-stream dams in unproclaimed areas. In the absence of water allocation planning and water licensing, it is difficult to ensure water practices are sustainable. The Whicher Water Resources Management Committee identified the licensing of surface water resources in the Cape to Cape subregion as a priority issue. The proclaimed groundwater areas and surface water management areas are shown in Figures 14 and 15 respectively. Figure 16 shows the proclaimed surface water management areas.

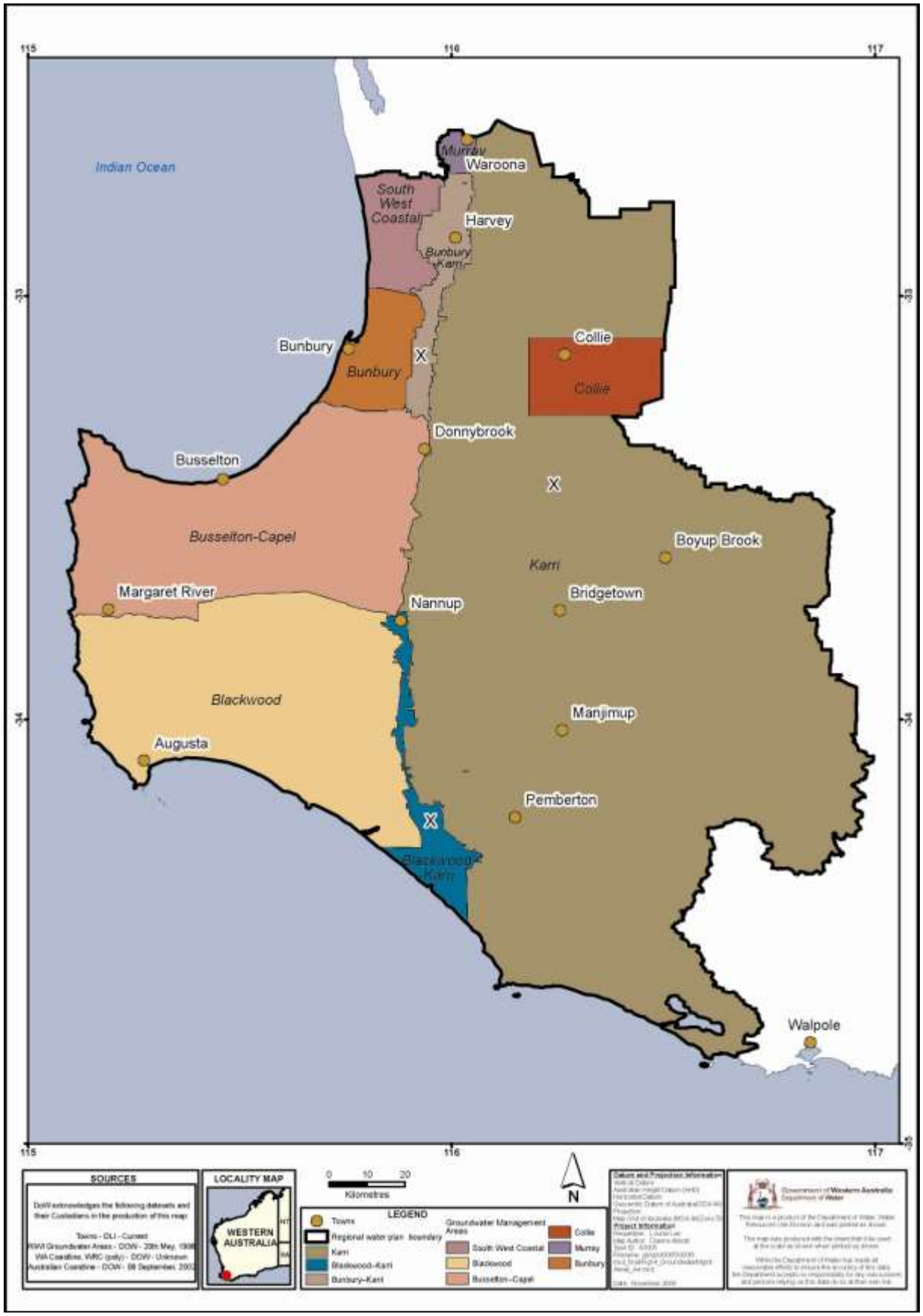


Figure 14 *Proclaimed groundwater areas (unless marked with an x)*

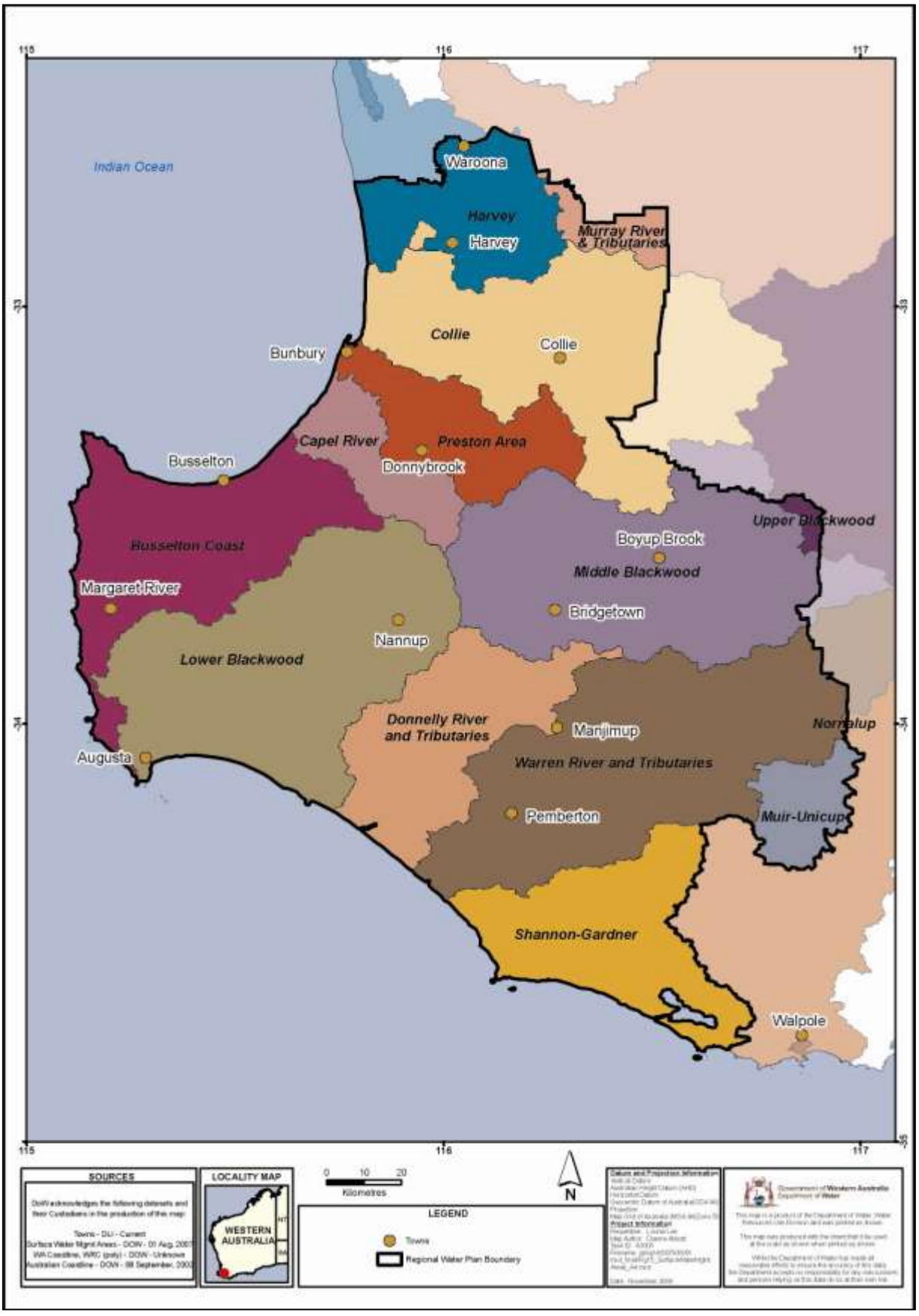


Figure 15 *Surface water management areas*

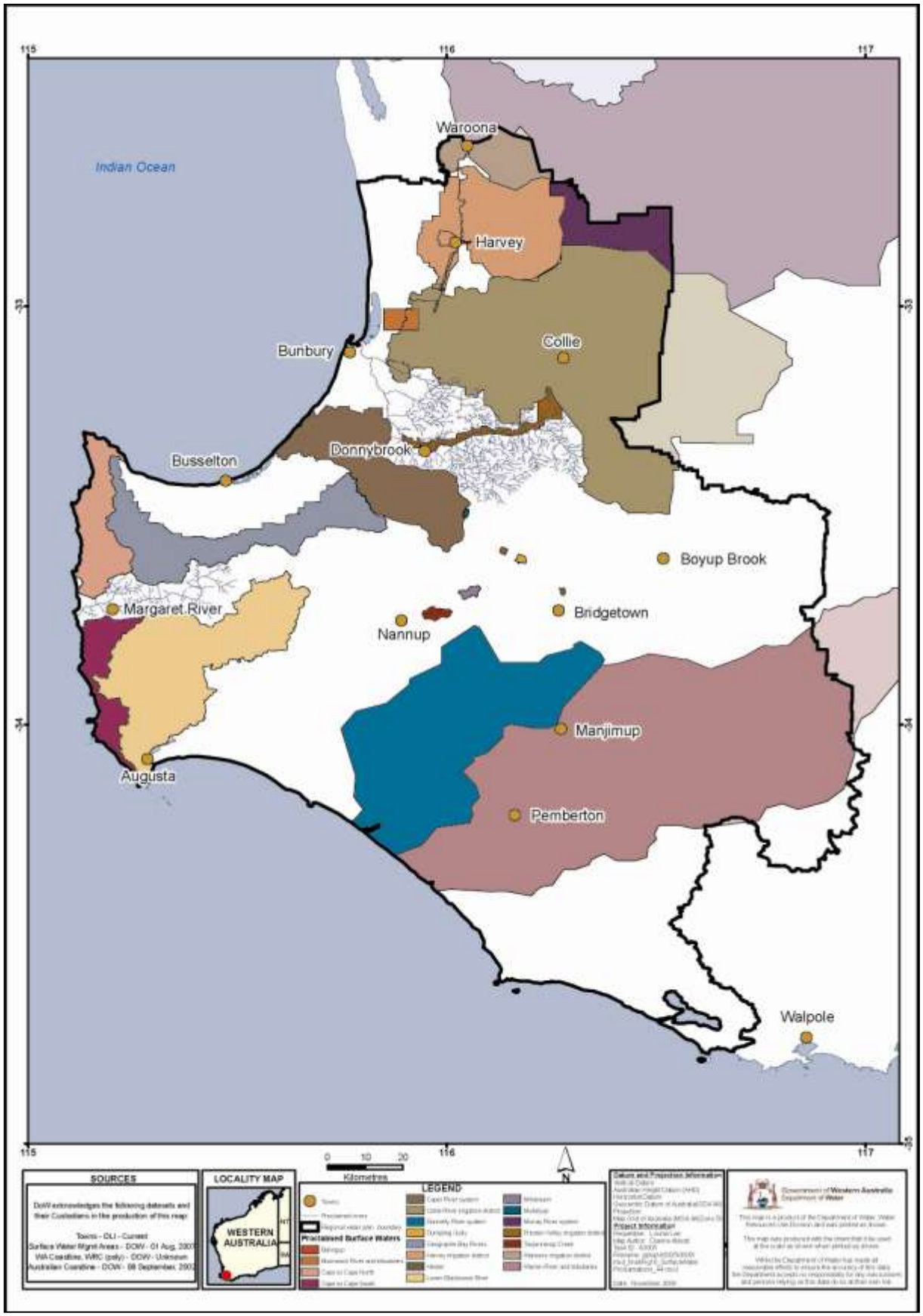


Figure 16 *Proclaimed surface water management areas*

5.3 Regulating water extraction

Water extraction licences

Under the *Rights in Water and Irrigation Act 1914*, a person is required to have a licence to draw water from either a surface water or groundwater resource within a management area proclaimed under the Act, and all artesian wells throughout the state. The exception is water taken for livestock[16] or domestic purposes from the shallow watertable aquifer or riparian watercourse.

Most private groundwater abstraction is licensed in the south west. However, the licensing of private surface water extraction has lagged behind the significant increase in resource use in some proclaimed areas.

The department has identified priority areas for licensing, which will be undertaken on a subarea basis. In the recently proclaimed surface water resources in the Cape to Cape subregion (see Figure 16), the taking of water via on-stream dams or direct river pumping by both new and existing surface water users will require a water licence. The department will continue licensing efforts in newly proclaimed catchments to improve knowledge of water-use.

Water access entitlements and consumptive pools

With the enactment of the new water legislation, consumptive pools[17] and water access entitlements (WAEs) [18] will be introduced to the south west in areas where there is significant demand for water from a variety of users. In these areas, WAEs will be issued to existing water licence holders in the **form of shares** in the consumptive pool. The share value will equal a volume of water as determined in the water allocation plan; for example, one share may equal one kilolitre.

WAEs will:

- be issued in perpetuity
- provide a clearly specified share of the water resource
- be listed in a share register.

The volume of water in a consumptive pool may change over time due to a drying climate or other factors as described in a relevant allocation plan. Consequently, the value of the share may change. Using the same example, one share may equal 0.9 kilolitres or in exceptional circumstances, the value may exceed one kilolitre.

The volume of water that corresponds to each share will be announced on a periodic basis, which may be seasonally or annually. Revision of statutory water allocation

[16] This excludes stock being raised under intensive conditions such as feedlots.

[17] A volume of water within a defined water resource that is available for consumptive purposes once the environmental water needs have been satisfied.

[18] A perpetual entitlement to exclusive access to a share of water from a specified consumptive pool as defined in a relevant statutory water allocation plan.

plans (approximately every 10 years) will allow for changes in the consumptive pool over time, and for water access rules to be adjusted (e.g. the rates, times and circumstances under which water may be taken).

As the department transitions to consumptive pools and WAEs, it will build capacity and knowledge within the community to adapt to this new regime.

Where there is little competition for water, a consumptive pool may not be defined and current water licence arrangements would continue to apply. Rights to water for livestock and domestic purposes, as currently defined under the *Rights in Water and Irrigation Act 1914,* will continue to exist under the new legislation.

5.4 Self-management groups

The irrigation review and water reform process (2005–07) identified that irrigation cooperatives have produced many benefits for agricultural producers and water management in Western Australia (Irrigation Review Steering Committee 2005; Department of Premier and Cabinet 2007).

Self-supply irrigators in the south west have stated an interest in exploring the possibility of forming self-management groups. This has been driven by factors such as the prospect of greater cost recovery for water resource management, strengthened water entitlements, introduction of water licensing fees and significant increases in regulatory requirements for self-supply irrigators.

To address this interest, the Department of Water initiated a project in February 2008 to look at the feasibility of self-management for self-supply irrigators. The department will develop a position on self-management options before June 2010.

6 Management of waterways, estuarine wetlands, floodplains and drains

Refer to the actions identified in the Strategic directions and actions *document under Theme 3: Manage water resource health and values.*

The south west is a global biodiversity hotspot. The region's waterways, wetlands and other water-dependent ecosystems are fundamental to this global significance. They provide habitat for aquatic and terrestrial flora and fauna, support biodiversity and are significant regional assets. The region's waterways also:

- support water-dependent ecosystem values
- drain land, transport and store water and carry flood waters
- provide opportunities for recreation and community activities
- provide a source of water for drinking and household use, fisheries, aquaculture, agriculture, mining and other types of industries
- are an important part of Indigenous and non-Indigenous heritage
- provide distinct landscape features and have aesthetic values
- are an integral part of the natural environment and landscape of the region and contribute to broadscale landscape and ecological processes.

The south west contains some high-conservation-value waterways and wetlands including:

- Lake Preston (part of the Peel-Yalgorup system) and the Vasse-Wonnerup Ramsar wetlands
- wetlands and waterways in the *Directory of important wetlands of Australia* (Environment Australia 2001) including Benger Swamp, McCarleys Swamp (Ludlow Swamp), the Blackwood River (lower reaches) and tributaries system, Gingilup-Jasper wetland system, Doggerup Creek system and Lake Maringup
- Wild Rivers including Blackwater Creek, Doggerup Creek system, Forth River, Inlet River and Shannon River
- water-dependent threatened ecological communities and water-dependent systems in the conservation estate.

6.1 Relationships between waterways, their estuaries, floodplains and drains

Waterways (including their floodplains, estuaries and inlets) and drains are closely linked (Figure 17) and their management is integral to total water cycle management. Waterways and estuarine wetlands are the natural drainage systems of the region. A floodplain is the portion of a waterway valley covered with water when it overflows its banks during major flows. Drainage is the land-use practice of moving water across

the landscape, which often involves modification of, or discharge to, natural waterway systems.

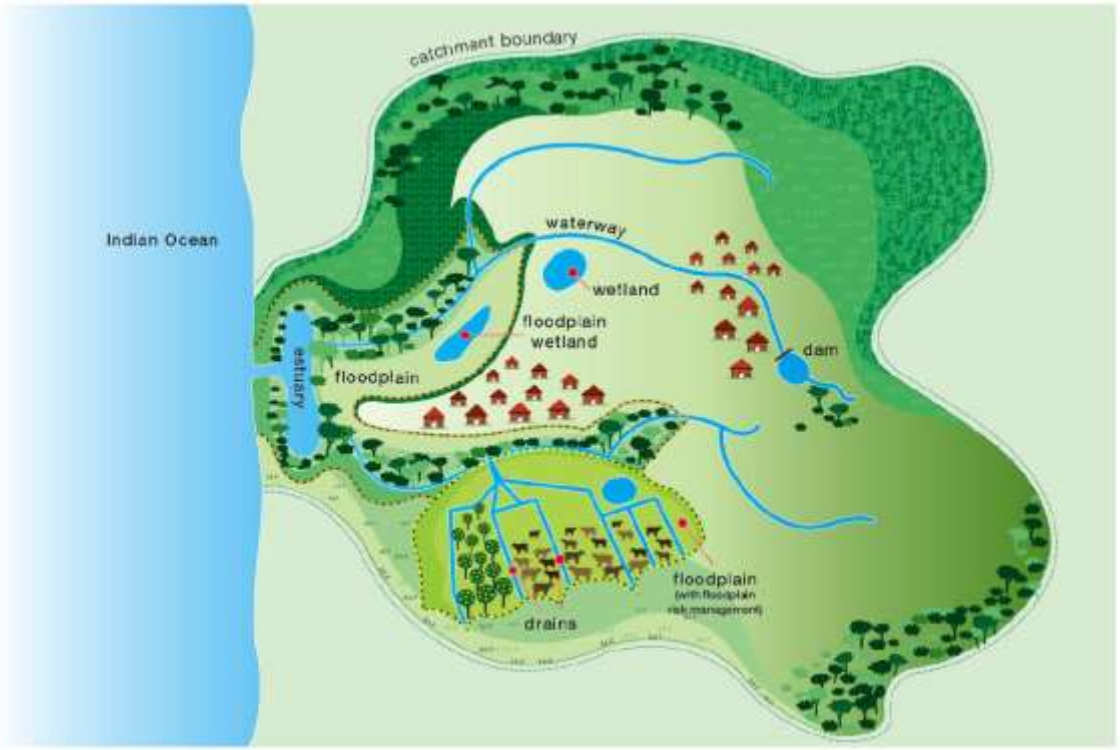


Figure 17 *Relationship between waterways, floodplains and drainage*

6.2 Management activities

Management is required to ensure the values of waterways, wetlands and other water-dependent ecosystems are maintained to an appropriate standard. Waterway, wetland, drainage and floodplain management activities in the South West region include:

- developing and implementing policies, strategies and management plans
- identifying ecological water requirements (e.g. identifying surface water flow and groundwater-level requirements to maintain or improve values)
- determining environmental water provisions
- developing drainage and water management plans that include an assessment of all water resources within the plan area
- identifying floodplain areas, recommending flood mitigation techniques and controls for development and providing flood warning advice
- identifying wetlands and waterways and assessing their economic, social and ecological values
- assessing impacts of proposed land uses on waterway, wetland and drainage management through statutory planning processes, via the *Better urban water management* (WAPC 2008) framework; for example, reviewing referred development applications, responding to a *Notice of intention to drain* from the

Commissioner of Soil and Land Conservation, and establishment of foreshore areas for waterways and buffer areas for wetlands

- monitoring wetland and waterway conditions and trends (e.g. flow rates, water quality and vegetation condition)
- managing wetlands and waterways in the conservation estate and maintaining the ecological character of those listed under the Ramsar Convention on Wetlands
- managing habitats that support species listed under international agreements
- managing algal blooms and fish-kill responses
- progressing waterway and wetland restoration and education (e.g. managing demonstration sites, capacity building, training courses, providing advice and supporting catchment councils to prepare salinity recovery and action plans)
- assessing the downstream impacts of salinity management activities and management of particular systems and land-use impacts
- assessing proposals to interfere with the beds and banks of waterways through the *Rights in Water and Irrigation Act 1914* bed and bank permit process.

Responsibilities

The Department of Water is the lead agency for waterways management in Western Australia. The department identified priorities for waterways management in the *State waterways initiative: strategic directions for the future* (DoW 2008). These include preventing and minimising the degradation of waterways and supporting restoration of degraded waterways.

Management and protection to prevent and minimise degradation of waterways is a high priority for the department, and includes:

- Policy development and planning; for example, reforming water resources management legislation, statewide waterways and foreshore area policies, ecological water requirements[19] and environmental water provisions[20] policy and draft Western Australian floodplain management strategy.
- Management; for example, development of ecological water requirements and environmental water provisions, flood risk plans, developing waterway management plans, authorising bed and bank disturbance (under the *Rights in Water and Irrigation Act 1914*), recommending conditions for land-use and

[19] Ecological water requirements (EWRs) are defined as the water regime needed to maintain the ecological values of water-dependent ecosystems at a low level of risk.

[20] Environmental water provisions (EWPs) are defined as the water regime provided as a result of the water allocation decision-making process taking into account ecological, social and economic impacts. They may meet in part or in full the ecological water requirements.

development proposals through the statutory referral system and management of high-value systems that are outside the conservation estate[21].

- Assessment; for example, the statewide method for prioritising waterways management; as well as investigation and monitoring of waterway health, quality and quantity, evaluation of trends, estuary remediation and algal bloom management techniques and responding to fish deaths.

The Department of Water also supports river restoration, builds community capacity to undertake river restoration and contributes to river action plans through funding programs such as the state NRM funding program and the Australian Government's Caring for Our Country program. River restoration includes engineering works for erosion management, riffle and fishway construction, fencing and riparian vegetation restoration.

Waterways and their catchments often have multiple landowners, so the Department of Water's policies facilitate a coordinated and cooperative approach with all relevant private and public land and water managers.

The Department of Environment and Conservation (DEC) is responsible for the management and conservation of wetlands and biodiversity throughout the state, waterways in the conservation estate, statewide coordination of the Ribbons of Blue community education program; as well as administration of native vegetation, industry regulation processes, unauthorised discharge and matters involving harm to the environment (under the *Environmental Protection Act 1986*).

The Minister for Water and the Department of Water must also consider wetlands management as part of their responsibilities for total water cycle management.

The Environmental Protection Authority is responsible for environmental impact assessment (with help from DEC) and for developing environmental protection policies under the *Environmental Protection Act 1986*.

Management and restoration

Sustainable management is required to ensure the values of waterways, wetlands and other water-dependent ecosystems are maintained. Many of the waterways and wetlands in the south west have become degraded by:

- loss of wetland and riparian vegetation
- soil erosion and sedimentation due to catchment clearing (e.g. filling in of river pools and channels)
- weed invasion
- regulation of waterways by dams and other flow-control structures

[21] High-value waterways differ from high-conservation-value waterways, as their management may require a balance between a range of environmental, social and economic values. In comparison, management of high-conservation-value waterways may be focused on conservation estate areas; attaining a comprehensive, adequate and representative reserve (CARR) system; and maintaining biodiversity, valuable species and ecological communities.

- altered water regimes (due to clearing, extraction, irrigation, drainage)
- altered fire regimes
- worsening of water quality (e.g. increased salinity and nutrient levels).

The *Framework for the Assessment of River and Wetland Health* (FARWH) is a national approach for assessing river and wetland health. It is based on a premise that ecological integrity is represented by all the major components of the environment that constitute the aquatic ecosystem. Therefore to determine health it is necessary to assess a number of factors under six major themes: disturbance, hydrological change, water quality, physical form, fringing zone, and aquatic biota. The FARWH is being trialled in the south west with a report due in 2010.

Waterways and wetlands with significant values are described in Section 2.3. Waterways and wetlands of international and national significance are shown in Figure 5 (Section 2.3). Figure 18 describes land uses that may impact on waterways and catchments.

Waterway management plans

The Department of Water, in partnership with the community, prepares management plans for those waterways that:

- have significant environmental, social and economic values
- require management and restoration to prevent or minimise degradation.

Waterway management plans will be advisory rather than legally binding documents. Such plans may include provision for:

- identifying waterway condition, pressures and community values
- recommending strategies to protect, restore and manage waterways and achieve outcomes that have been agreed through community consultation
- recommending strategies to improve water quality
- implementing community capacity building mechanisms
- establishing monitoring and reporting requirements for the plan's implementation and review.

The department has no waterway and wetland management plans proposed for the South West region, although it has developed major components of such plans including the *Vasse-Wonnerup water quality improvement plan* and the draft *Collie River salinity recovery plan*. In addition, the *Leschenault water quality improvement plan* and the *Warren River salinity recovery plan* are undergoing development. Various river action plans are also available or currently being prepared.

Management priorities

The *State assets report* (Government of Western Australia 2007b) provides a broad assessment of the value of, and degree of threats to, waterways and wetlands in the

South West. The *State waterways initiative* (DoW 2008b) sets priorities for waterways management to 2011.

The initiative includes actions for improving waterways planning and management, identifying priorities for waterways management, supporting measures to protect environmentally significant waterways and supporting waterways restoration. The actions will address two management priorities, including preventing and minimising degradation of waterways and repairing degraded waterways. Further details on this initiative are available of the Department of Water's website.

The Department of Water and the DEC have supported work by the South West Catchments Council (SWCC) to produce a *Waterway Health Sub-strategy* (WHSS) and an *Investment Decision Support System* (IDSS

The WHSS establishes the principles and methodologies to prioritise the management of waterways, estuaries and those wetlands of national and international significance. The IDSS provides an ongoing knowledge base on the attributes of and threats to assets. It will improve the capacity of NRM groups and state government agencies to prioritise management needs and help with the implementation of actions in a transparent and systematic way.

The WHSS and IDSS will help to determine which waterways will require the first waterway management plans. Priorities will recognise that management and protection of waterways at an early stage (i.e. before they become degraded) is likely to minimise more costly remedial work in the future.

6.3 Drainage management

Drainage systems collect and transport water from and to natural and modified waterbodies in the landscape. In urban, commercial and industrial areas, drainage management systems are used for stormwater, groundwater and floodplain management. In rural areas, drainage systems are used in irrigation, to drain waterlogged agricultural soils, to manage salinity or to control flooding. In the south west, urban and rural drains are major contributors of nutrients, pollutants and silt to receiving waterbodies. However, in some catchments the drainage systems are providing most of the flow into the natural systems, which helps to mitigate some of the impacts caused by dams and extraction.

Drainage should be managed to protect the health of receiving waterbodies:

- waterways
- wetlands
- estuaries
- marine environments and
- other water-dependent ecosystems.

The best-practice approach replicates natural drainage processes, and is different to the traditional drainage management approach of using constructed, piped drainage

and channels that discharge surface water and groundwater to receiving waterbodies faster than natural processes.

Responsibility for drainage governance

Several agencies have governance roles in drainage management in the region:

- The Department of Water is responsible for policy development, strategic planning and setting design objectives and criteria, particularly for urban drainage systems
- local governments are responsible for managing constructed drainage infrastructure within their jurisdictions
- The Water Corporation is licensed by the Economic Regulation Authority to provide rural drainage services for main or arterial (gazetted) drains in drainage districts proclaimed under the *Land Drainage Act 1925*
- The Commissioner of Soil and Land Conservation regulates inland rural drainage through the use of the 'notice of intention to drain' process.

There are three components to the Department of Water's drainage program:

- urban stormwater management
- coastal drainage
- wheatbelt drainage.

Urban stormwater management

Urban stormwater systems are created to facilitate urban development by preventing flooding and controlling groundwater levels and discharge. Urban expansion has seen a dramatic increase in the amount of land covered by impervious surfaces. This has resulted in increased local runoff, modified groundwater recharge and a greater risk of pollution and flooding of constructed infrastructure such as commercial and residential buildings.

Traditionally, urban stormwater systems focused on efficiently collecting and conveying all stormwater from residential, commercial and industrial areas. This was achieved using constructed pipes and channels that discharged directly into the environment. However, when drainage water is conveyed by a pipe or constructed channel, it is likely to:

- collect contaminants and litter from constructed impervious surfaces
- cause significant changes to the volume of surface water flows and frequency of peak flows in receiving waterbodies, which harms aquatic ecosystems by modifying habitats and hydraulic regimes
- introduce weeds and pests into receiving waterbodies, which compete with native species and cause adverse impacts on habitat diversity and biodiversity.

During the past 15 years there has been a dramatic shift in stormwater planning towards replicating natural processes by:

- retaining natural drainage systems such as waterways and wetlands, including their floodplains and buffers
- retaining and detaining frequent rainfall events as high in the catchment and as close to the source as possible
- retaining or detaining moderate to large rainfall events in road reserves, public open space and waterbodies (this requires safe passage of water by overland flow paths)
- 'disconnecting' constructed impervious surfaces from receiving waterbodies; for example, by installing pervious surfaces and infiltration devices and retaining native vegetation and gardens where possible
- minimising the use of constructed pipes and channels.

Contemporary urban stormwater management also addresses the management of flood events for the protection of properties. It considers drainage water as a valuable resource to be protected, conserved and re-used. Managed appropriately, stormwater can supplement household, commercial/industrial, streetscape and parkland water needs, while ensuring the groundwater aquifer supply and surface water ecosystems are maintained.

The *Stormwater management manual for Western Australia* (Department of Water 2004–07) provides guidance on implementing best-practice urban stormwater management and water sensitive design.

A framework for urban water management and water sensitive urban design, prepared as a partnership between the Department of Planning, the Department of Water, the Western Australian Local Government Association and the Australian Government, was published by the Western Australian Planning Commission (WAPC) in October 2008 and entitled *Better urban water management*.

This framework ensures that water is considered at appropriate stages of the land-use planning process. At each key stage of the planning process a progressively more detailed plan is required to be produced to support the planning decision. A drainage and water management plan (as discussed in the next section) is one such plan, and operates at a high level.

Urban drainage: drainage and water management plans

Drainage and water management plans help address water issues in areas of proposed urban development in the region, particularly on the Swan coastal plain. The plans combine existing knowledge with groundwater and surface water modelling, and address land-use and planning matters. The plans cover water quantity and quality issues and show features relating to natural drainage. The plans will assess the total water cycle and, as such, incorporate all natural and modified surface water and groundwater systems.

While the Department of Water's drainage planning sets the standards and objectives for detailed drainage planning at the district, local and subdivision scales, local governments and developers are responsible for the detailed local level planning.

The department, in consultation with local and state government planners, will consider areas proposed for significant future urban development and, where deemed appropriate given state priorities, may prepare either generic water management advice or conduct background studies for the preparation of drainage and water management plans.

Coastal drainage

Most coastal drainage systems in the south west were constructed during the first half of the last century. The Busselton, Roelands and Harvey drainage districts were declared under the *Land Drainage Act 1925*. These systems drain previously waterlogged and inundated coastal plain. These areas constitute some of the most productive lands in the state, and they supply a wide range of agricultural produce including milk, meat and vegetables.

The Water Corporation is responsible for maintaining rural main or arterial (gazetted) drains at a level that ensures landowners within drainage districts are not inundated for periods that will significantly affect their assets and the commercial activities being carried out on the land. This is in accordance with its operating licence from the Economic Regulation Authority. Branch drains are owned and maintained by the private landowners whose land they drain.

If best-practices are not employed in agricultural production, nutrients (such as phosphorus and nitrogen), pesticides and soil erosion products (sediment) can enter the drainage system and ultimately reach waterways and their estuaries and wetlands. Information and education campaigns by government agencies, NRM groups, local governments and the agricultural sector have increased awareness within the agricultural community of the contribution of rural drainage to water quality issues in the south west.

The Department of Water's coastal drainage program aims to balance the benefits of drainage for agricultural production and the transition in some areas to urban development, with the need to maintain healthy waterbodies. The department released a coastal drainage brochure and *Coastal drainage discussion paper* in 2008 to identify key management, operational and maintenance issues related to drainage in south west coastal areas. The paper was prepared following regional site visits and literature reviews that covered the Albany, Waroona, Harvey, Roelands, Busselton and Mundijong drainage districts and the Scott River catchment.

A number of actions recommended in the paper were addressed during 2007–08. A key outcome was an agreement being reached between key stakeholders, including the Water Corporation and the Economic Regulation Authority, that the objectives of drainage on the coastal plains needed to be reviewed.

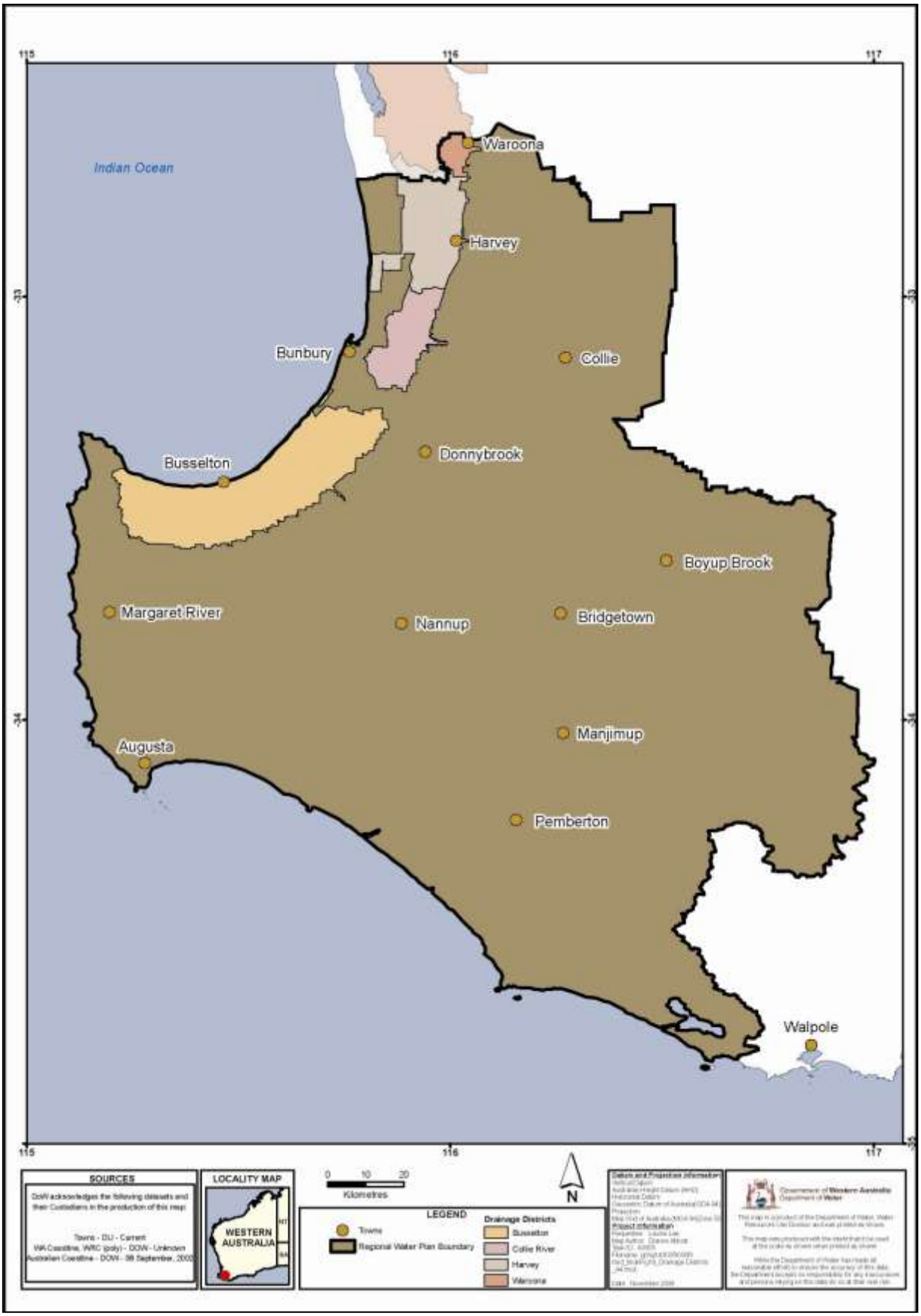

115
116
117
33
34
Indian Ocean
Waroona
Harvey
Bunbury
Collie
Donnybrook
Busselton
Boyup Brook
Margaret River
Nannup
Bridgetown
Manjimup
Augusta
Pemberton
Walpole
SOURCES
LOCALITY MAP
WESTERN AUSTRALIA
0 10 20
Kilometres
N
LEGEND
Towns
Regional Water Plan Boundary
Drainage Districts
Busselton
Collie River
Harvey
Waroona

Figure 18 *Drainage districts*

Based on this agreement, a draft *Management response framework* was developed. This document assessed the changes in governance needed to enable additional objectives (e.g. water quality and re-use) to be incorporated into design, operation and maintenance practices.

The Department of Water will continue to work with the Water Corporation and the Economic Regulation Authority to progress this work.

Wheatbelt drainage

Most of the surface water basins in South West region extend eastward of the *South West regional water plan* boundary (e.g. the Blackwood River basin). Land-use and water management activities in these upper catchments can have a significant impact on downstream water uses within the Plan area.

In the wheatbelt, salinity is one of the biggest threats to rural land, water and biodiversity resources, and farm-scale drainage has been practised for at least two decades in an attempt to manage salinity. More recently, deep drainage[22] in the form of large-scale arterial drainage has emerged as a possible salinity management option (DAFWA 2000). A number of deep-drainage proposals have also been developed in the upper Blackwood River catchment. The state government is committed to assessing the sustainability of drainage as a salinity management option through programs such as the Department of Water's *Engineering Evaluation Initiative*, the *Salinity Investment Framework* and the *Wheatbelt Drainage Evaluation Program*.

Through these programs, the department is researching issues of water resource management related to wheatbelt drainage, in the context of responding to community-driven proposals for deep drainage. Various projects researching downstream impacts, stream hydrology, drain design and governance are nearing completion and reports are in preparation. Another key area being investigated is a process to improve the way the Department of Water responds to a *Notice of intention to drain* (NOID) from the Commissioner of Soil and Land Conservation.

A person proposing to drain salty groundwater must complete a NOID and submit the notice to the Commissioner of Soil and Land Conservation, who then asks the Department of Water to comment on the proposal. The Commissioner will then determine if there is a problem with the proposal. The Commissioner encourages all farmers considering draining salty groundwater to submit a NOID.

[22] Drainage is commonly described as either shallow (surface) or deep (subsurface), which includes relief wells and groundwater pumping.

6.4 Floodplain management

Flooding along a waterway or stream occurs when sufficiently heavy or prolonged rainfall produces runoff that overflows the main channel. This is a natural process in all waterways and is the reason why floodplains are so productive. Low-lying land adjacent to coastlines and estuaries may also be flooded as a result of extremely high tides or storm surges accompanying severe storms.

Catchments have been physically modified, with changes to their surface water and groundwater hydrology the result. Land-use practices that have induced this change include clearing, de-snagging of waterways and development of drainage networks. Pressure for more intensive use of floodplains continues. This pressure is increasing as desirable undeveloped land becomes scarce in high-growth areas.

Floodplains should be managed for the benefit of the whole community such that the risks and damages are minimised and environmental values are protected. The management objectives are to:

- ensure catchment land-use minimises flood risk and costly damage
- ensure all levels of government and the local community accept their responsibilities in floodplain management
- ensure appropriate floodplain mitigation measures minimise damage and are acceptable to the local community
- promote the use of non-structural rather than structural mitigation measures where possible
- ensure that floodplain management measures have economic, social and environmental outcomes
- provide flood forecasting and warning systems and support emergency management arrangements that cope with the impact of flooding.

Non-structural measures aim at reducing or avoiding the susceptibility of new developments to flood damage, as well as reducing the impact of flooding on existing developments. They include land-use and building controls, acquisition of land and relocation, effective flood forecasting and flood warning, creating public awareness and flood insurance.

Structural measures physically modify the natural behaviour of flooding and are designed to reduce the frequency or impact of flooding on existing developments. They include levee banks, channel improvements, river diversions, retarding basins and flood-mitigation dams.

Roles and responsibilities

The Department of Water has completed the draft *Western Australian floodplain management strategy* (2009). It provides advice on and recommends guidelines for development on floodplains with the objective of minimising flood risk and damage.

The department:

- develops floodplain mapping and floodplain development strategies for existing and future urban areas that are affected by major river flooding
- provides advice to the Department of Planning[23] (for land-use planning purposes), local government (for development controls) and other agencies
- helps with flood forecasting in association with the Bureau of Meteorology and the Fire and Emergency Services Authority of Western Australia (FESA)
- facilitates the construction of flood mitigation works.

The department uses the following guiding principles to ensure that proposed development in flood-prone areas is acceptable with regard to major flooding:

- provision of adequate protection against a 100-year average return interval (ARI) flood
- no detrimental impact on the existing 100-year flooding regime of the general area.

Implementation of the department's advice takes place under the provisions of the *Planning and Development Act 2005* (WA), the *Building Code of Australia* and the *Better urban water management* (WAPC 2008) framework. Drainage and water management plans include assessments of flood risk, and this information needs to be considered in the appropriate detail at the relevant land-use planning stage under the *Better urban water management* framework.

The principal role of local government in floodplain management is the implementation of floodplain management strategies. This is achieved by land and development controls through statutory planning, and by various building regulations. The most recent is the Wagin floodplain management strategy developed by the Department of Water and presented to the Shire of Wagin in 2008.

The Water Corporation is responsible for the maintenance of flood mitigation works, as detailed in their Economic Regulation Authority water service licence agreement, in the following areas:

- Preston River levee banks (Bunbury)
- Vasse River Diversion levee banks (Busselton).

Flooding in the south west

The 100-year ARI flood has been generally adopted in Australia and overseas as the basis for floodplain management planning. The ARI is an indication of how frequently a flood of a particular size is likely to occur on average. A flood the size of a 100-year ARI is likely to occur once in 100 years on average, but has a 1 per cent chance of occurring in any one year. A flood the size of a 10-year ARI is likely to occur once in 10 years on average, and has a 10 per cent chance of occurring in any one year.

[23] Previously Department for Planning and Infrastructure

Flood events in the south west have been infrequent, as shown in Table 11. Since the mid 1970s relatively little major flooding has occurred in the region's more populated areas or in the more flood-prone areas of Bunbury, Collie and Busselton. This does not indicate a decreased risk from flooding.

Table 11 *Major river flood events in the South West*

River	Year	ARI (years)
Collie River	1945	10
	1963	10
	1964	40
	1974	10
	1982	25
Preston River	1964	100
	1974	10
Blackwood River	1955	15
	1963	20
	1964	50
	1982	125

Source: Water and Rivers Commission 2000 (ARI = average return interval**)**

The Busselton town site is adjacent to low-lying land, waterways and wetlands. Significant flooding of the town occurred both in 1997 and 1999. A review of this flooding indicated that Busselton had only 20-year ARI flood protection and not, as was previously thought, 100-year ARI flood protection. A number of options to alleviate the flooding problems were evaluated and after community consultation, the chosen option was the retaining of floodwaters in the upper catchment of the Vasse River Diversion through a network of detention basins. The first two detention basins were completed in 2001 and 2003, with construction of a third and final detention basin completed in 2009.

Floodplain mapping

The Department of Water's floodplain mapping identifies the extent and level of 100-year ARI flooding, including floodway areas and the flood fringe. (A flood fringe is the area of the floodplain affected by flooding but outside the floodway, see Figure 20). These areas are generally covered by still or very slow moving waters during a 100-year flood. A floodway is the river channel and the portion of the floodplain that forms the main flow path of flood waters once the main channel has overflowed.

In floodplain development plans, the following points need to be taken into account:

- Proposed development (e.g. filling and building) within the flood fringe is considered acceptable with respect to major river flooding. However, a minimum habitable floor level of 0.5 m above the adjacent 100-year ARI flood level is generally recommended to ensure adequate flood protection.

- On the other hand, development proposed within the floodway and considered to be obstructive to major river flows is not acceptable. Such development would detrimentally impact on the existing flooding regime of the general area.
- Other planning issues such as environmental and ecological considerations (e.g. protection of riparian vegetation and water quality management measures) may also need to be addressed.

A foreshore area determined in accordance with the *Foreshore policy no. 1: Identifying the foreshore area* (WRC 2002) may be within a floodway. There is a presumption against land development in the foreshore area unless a proponent can demonstrate that any adverse impacts can be managed to Department of Water requirements.

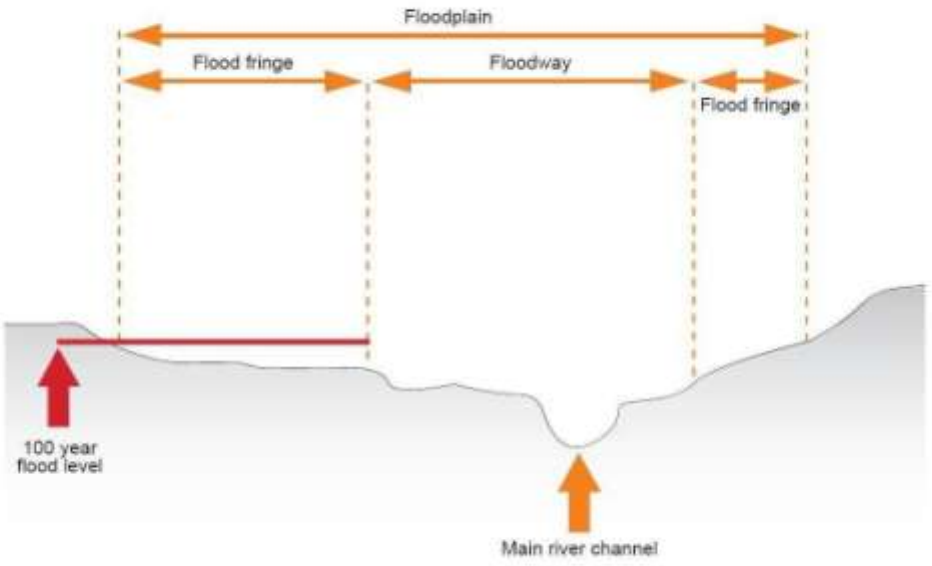


Figure 19 *Components of a floodplain*

In the south west, floodplain mapping has been completed for a number of existing and future urban areas that are flood prone (Table 12). The schedule for further floodplain mapping is shown in Table 13.

Table 12 *Areas with 100-year ARI floodplain mapping completed*

Floodplain	Location
Preston River	Bunbury (Leschenault Inlet to Picton Bridge)
	Bunbury (Picton Bridge to Riverlands)
	East Bunbury
	Donnybrook

Floodplain	Location
Eedles Gully	Preston River to Bunbury Aerodrome
Five Mile Brook	Bunbury
Collie River	Leschenault Inlet to Australind Bypass
	Collie townsite
Brunswick River	Collie River to Australind Bypass
Busselton	Busselton region
Toby Inlet	Quindalup
Margaret River	Margaret River townsite
Capel River	Capel
Blackwood River	Boyup Brook, Bridgetown, Nannup, Augusta to Warner Glen Bridge

Table 13 *Floodplain mapping schedule for the South West*

Location	2009–10	2010–11
Ferguson River (Picton)	√	
Collie River (Leschenault Inlet to South West Highway)	√	√
Brunswick River (Collie River to South West Highway)	√	√
Balingup Brook townsite		√

7 Public water supply

Refer to the actions identified in the Strategic directions and actions *document under Theme 5: Provide integrated water services for urban communities.*

7.1 Managing drinking water health risks

The Department of Water works with stakeholders and state agencies, such as the Department of Health (DoH), Western Australian Planning Commission (WAPC), Department of Planning (DoP) and water service providers, to manage water quality in drinking water catchments. It develops and implements drinking water source protection plans (DWSPPs) which identify existing and potential threats to a drinking water source.

The *Australian drinking water guidelines* (NHMRC & NRMMC 2004) provides the nationally recommended framework for good management of public drinking water supplies that, when implemented, will ensure safe water and protect public health.

Western Australia has adopted a 'catchment to consumer' multiple barrier approach to managing drinking water quality. Catchment management and water source protection provide the first barrier for the protection of water quality. Protecting drinking water at the source reduces the amount of treatment needed before it reaches consumers. This is better from both a risk and a cost perspective.

All three water service providers in the south west meet health criteria set out in the *Australian drinking water guidelines*, as monitored by the Western Australian Advisory Committee for the Purity of Water (chaired by DoH).

7.2 Drinking water source protection plans (DWSPPs)

Some groundwater and surface water sources in the region are designated for use as public drinking water. It is particularly important to protect these sources from contamination and reduce the need for costly treatment (which may add to the cost of water at the tap). In the first instance, land uses and recreational activities that pose a potential risk of contamination need to be kept away from sources of drinking water. DWSPPs identify existing and potential threats to a drinking water source and recommend management strategies to avoid, minimise or manage those risks.

The catchment areas of reservoirs and recharge areas of wellfields used as sources of public drinking water are proclaimed under the *Country Areas Water Supply Act 1947* (WA) or the *Metropolitan Water Supply Sewerage and Drainage Act 1909* (WA) as water reserves, underground water pollution control areas or catchment areas. There are 34 public drinking water source areas (PDWSAs) in the south west (Figure 21).

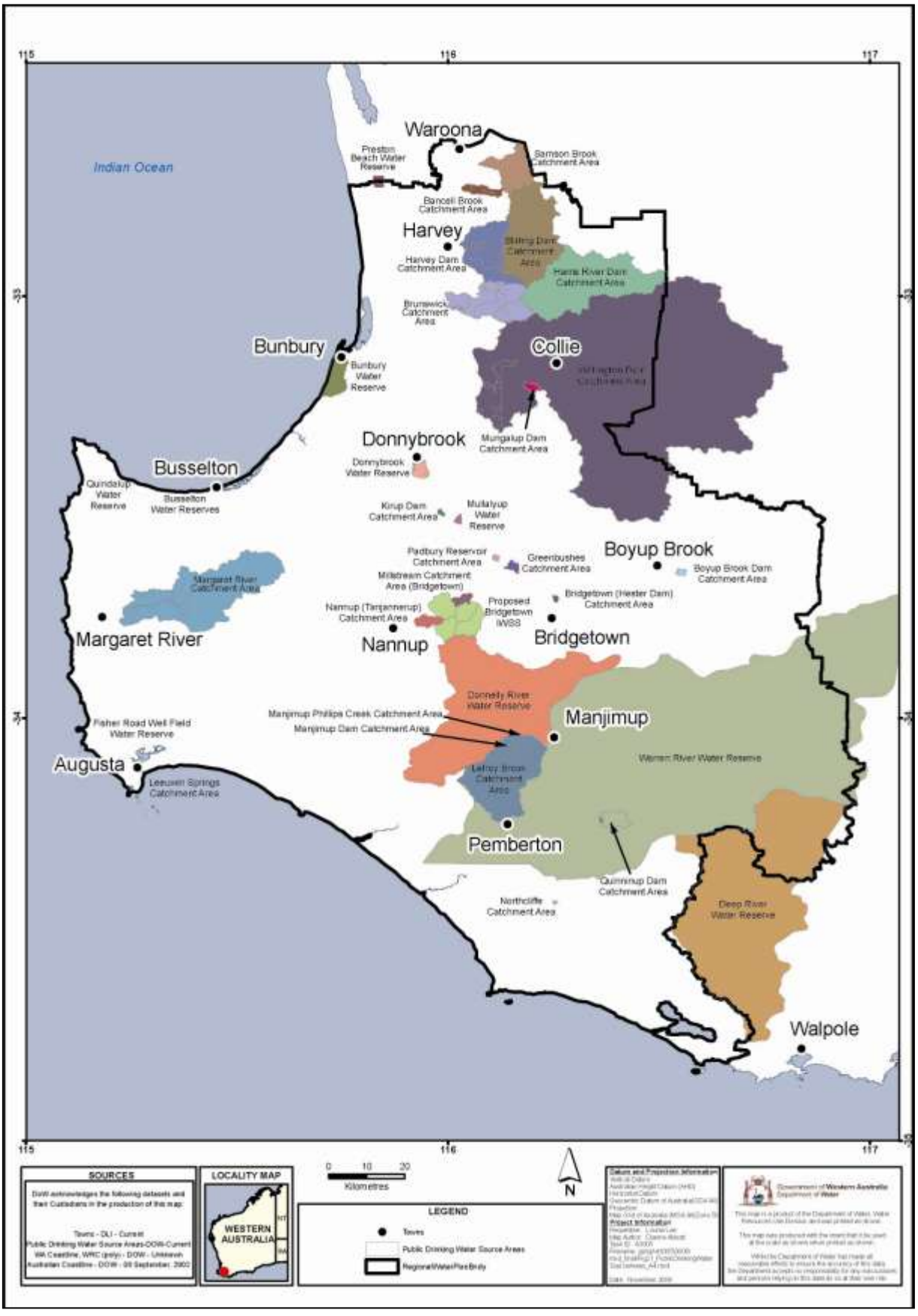


Figure 20 *Public drinking water source areas (2009)*

PDWSAs are proclaimed to protect water quality. Legislation exists to control land uses and activities and this legislation will be updated with the progress of the new Water Resources Management Bill.

The Department of Water prepares DWSPPs in consultation with relevant state government agencies, landowners, local government, industry and community groups. DWSPPs assign priority areas (priority 1, priority 2 and priority 3) and protection zones (wellhead protection zones and reservoir protection zones) to the PDWSA. These plans outline management strategies for protecting the water quality of the individual water sources. DWSPPs are readily available on the Department of Water's website <www.water.wa.gov.au>. The objectives of a protection plan are to:

- identify existing and potential threats to water quality
- determine how vulnerable a water source is to contamination
- determine preventative risk-management strategies and programs for the ongoing management and protection of the source
- raise community understanding and awareness of contamination risks
- guide land-use planning decisions and approvals to protect water quality
- recognise other ecosystem, social and public benefit outcomes arising from source protection
- contribute to broader catchment management through knowledge and science, management of land use, and monitoring and reporting of catchment activities.

Land-use compatibility

Statement of planning policy (SPP) 2.7 – public drinking water sources (WAPC 2003a) guides state and local government land-use planning decisions in PDWSAs through provisions in local and town planning schemes. The policy references the Department of Water's *Water quality protection note – land use compatibility in PDWSAs* (DEC 2004) which provides advice on the acceptability of land uses and activities within PDWSAs.

The potential environmental impacts of plantation logging in drinking water source catchments are addressed in the Forest Industries Federation of Western Australia *Code of practice for timber plantations in WA* (2006). This code does not, however, apply to native forests, but in Section 2: Plantation management principles, under 2.2.2(a), it is stated that native forest should not be cleared for plantation establishment where this would compromise regional conservation and catchment management objectives. Soft and hard wood plantations are considered to be compatible land-use activities with conditions (e.g. relating to vegetation buffers and pesticide use) in PDWSAs. Environmental best-management practices are provided in the code of practice.

Recreational activities

The Water Corporation's irrigation reservoirs in the south west are popular venues for water-based recreational activities, such as marroning, angling, skiing, canoeing and swimming. These reservoirs include the Harvey, Drakes Brook, Logue Brook and Waroona dams. The Department of Sport and Recreation, in consultation with the Department of Water, DoH, DEC and Tourism WA, is preparing a '*Southern Darling recreation strategy for inland water bodies and catchments*' for the south west (Dwellingup to Collie). This strategy will help to ensure recreational opportunities are provided for now and into the future. The strategy is expected to be available in 2010–11.

A very recent development is the establishment of a Parliamentary inquiry into recreational activities in PDWSAs. This inquiry is being conducted by the Legislative Council's Standing Committee on Public Administration. The Standing Committee plans to report to Parliament on this matter in July 2010. More details on this inquiry can be obtained from the Parliament website at <www.parliament.wa.gov.au> (choose Committees/About Committees/Legislative Council).

When developing DWSPPs, the Department of Water considers the following matters regarding the acceptability of various land-based and water-based recreational activities:

- the requirements of legislation
- the strategic importance of the public drinking water source
- *Statewide policy no. 13* and associated guidelines
- potential water quality risks from existing and approved future land uses within the water source area
- the rights of the owners or managers of land (including neighbouring freehold land)
- the statutory powers of government agencies covering the use and management of land
- the social and economic impact of historical recreational uses in the area
- the impact on areas of cultural significance for Aboriginal and/or other communities.

Status of drinking water source protection planning

The available DWSPPs for the south west are shown in Table 14. By 2015 all PDWSAs should have a plan developed. Each plan is developed in consultation with key water users and the community.

Table 14 *Status of drinking water source protection planning in the South West*

Public drinking water source area	Completed DWSPP	2010–11	Proposed DWSPP
Balingup Dam (Padbury Reservoir) catchment area		√	

Public drinking water source area	Completed DWSPP	2010–11	Proposed DWSPP
Bancell Brook catchment area			√
Binningup Beach (subject to review)			√
Boyup Brook Dam catchment area			√
Bridgetown catchment area (Hester Dam)			√
Brunswick catchment area	√		
Bunbury water reserve	√		
Busselton water reserve	√		
Deep River water reserve			√
Donnelly River water reserve			√
Donnybrook water reserve	√		
Quindalup (Dunsborough and Yallingup town water supplies)	√		
Eaton and Australind water reserves			√
Greenbushes (Dumpling Gully) catchment area			√
Harris Dam catchment area	√		
Kirup Dam catchment area	√		
Leeuwin Spring catchment area and Fisher Road wellfield water reserve (Augusta town water supply)	√		
Lefroy Brook catchment area and Big Brook Dam catchment area (Pemberton town water supply)			√
Manjimup Dam and Phillips Creek Dam catchment areas			√
Margaret River catchment area (Ten Mile Brook)	√		
Millstream catchment area (Bridgetown)	√		
Mullalyup water reserve			√
Mungalup catchment area (Collie water supply)		√	
Murray River water reserve (subject to review)			√
Myalup water reserve (subject to review)			√
Northcliffe catchment area	√		
Preston Beach water reserve	√		
Quinninup Dam catchment area	√		
Samson Brook catchment area (Waroona and Hamel town water supply)	√		
Stirling Dam catchment area	√		
Tanjannerup Creek Dam catchment area (Nannup town water supply)	√		
Warren River water reserve			√
Wellington Dam catchment area (possible future PDWSA, subject to public consultation)			√

7.3 Public water supply augmentation

Water service providers develop source development plans for all towns requiring supply augmentation. The Department of Water has reserved sufficient groundwater to meet anticipated town water supply needs in the south west for the next 30 years, but service providers will need to prepare and submit source development plans to access this water. These plans will estimate future needs based on efficient water-use, identify demand management measures, propose new supply sources and when they will be required, and set out the investigation and approval actions to secure new supply sources. For example, planning work is underway to augment the Northcliffe water supply from the Pemberton water supply.

The Department of Water will review the proposed source development plans to ensure that all reasonable water-use efficiency measures will be put in place, proposed surface water and/or groundwater resources are consistent with water allocation plans, and the proposed investigation and approval actions are sufficient to enable assessment of an application for a new licensed allocation.

Appendix D contains a list of all the Water Corporation's public water supply dams in the south west, including their storage capacity and primary uses.

Binningup seawater desalination plant

The desalination plant near Binningup will produce up to 50 GL of water per year, with the potential to increase to 100 GL/yr. Powered by renewable energy, the desalination plant is to be connected to the Integrated water supply scheme (IWSS) via a 25 km pipeline.

Construction is expected to take at least two years and the plant is scheduled to come on line in 2011–12. While seawater desalination is more expensive than traditional groundwater or surface water sources, it offers the advantage of not being dependent on rainfall.

Bunbury town water supply

Aqwest (Bunbury Water Board) supplies potable water to the City of Bunbury from groundwater bores drawing on the Yarragadee aquifer. The bores are relatively shallow and close to the coast, and hence are subject to the effects of inland movement of the saltwater interface. Some augmentation of the scheme will be required to meet growth in demand. New production bores will need to be deeper, further away from the coast and more widely spaced to minimise effects on the saltwater interface and other users.

Busselton town water supply

Busselton Water supplies potable water to the town of Busselton and surrounding areas from groundwater bores drawing on the Yarragadee and Leederville aquifers.

The Busselton Shire's population is projected to increase by nearly 40 per cent by 2021. The public water supply needs for this growth will be met by drawing additional water from the Yarragadee aquifer.

Bridgetown regional water supply scheme

The Water Corporation's interconnected Bridgetown regional water supply scheme will draw on both surface water and groundwater with the addition of a new groundwater production bore near Nannup. When completed, the scheme will provide a reliable high-quality water supply to the communities of Bridgetown, Boyup Brook, Balingup, Greenbushes, Hester, Kirup and Mullalyup – some of the communities hardest hit by declining rainfall. The bore will transfer groundwater from the Yarragadee aquifer in the Perth Basin to Millstream Dam, which will negate the need to take surface water from contingency sources including Ellis and Camp creeks.

As water demand increases, additional source capacity will be needed from the new production bore. Detailed investigations by the Water Corporation, including test pumping and environmental modelling, indicate the bore is capable of meeting future demand without having a significant impact on local groundwater users or the environment. It is now expected that the proposed pump-back dam on Nannup Brook may be deferred indefinitely, depending on growth and climatic considerations.

The new production bore near Nannup may have impacts on the Blackwood River, particularly during periods of drought and/or low flow. These potential impacts will be investigated thoroughly before approval for any expansion of the bores capacity.

Margaret River town water supply scheme

The Margaret River town water supply scheme supplies potable water to the town sites of Margaret River, Prevelly, Gnarabup and Cowaramup. Surface water is stored at the Water Corporation's Ten Mile Brook Dam on a tributary of the Margaret River. Water is also pumped directly from the Margaret River's main channel to top up the Ten Mile Brook Dam.

The Shire of Augusta-Margaret River's population is projected to increase by 40 per cent by 2021. Work is underway to secure the scheme by developing groundwater supply from the Yarragadee aquifer. Subject to further investigations and licensing requirements, draw will increase from about 0.8 GL/yr to about 1.2 GL/yr by 2021. The new source is scheduled for completion in 2012.

Gracetown and Witchcliffe water supplies

Located on Cowaramup Bay near Margaret River, Gracetown currently has no reticulated water supply or sewerage system because it is outside the Water Corporation licence area. Groundwater supply is limited due to the fractured rock aquifers in the area. In addition, the groundwater is brackish, with some contamination from septic tanks – hence most houses rely on rainwater tanks.

In 2005 the state government asked LandCorp to investigate the potential for additional residential development in Gracetown. Adopting sustainable community principles, LandCorp is seeking rezoning of the project area and developing a structure plan for Gracetown that will include a self-sufficient, non-potable water supply and a wastewater treatment system for the entire community. It is anticipated the structure plan will be advertised and adopted by the Shire of Augusta-Margaret River and WAPC during 2010–11. Construction of the subdivision is proposed to begin in 2012.

The shire is also evaluating sustainable community models for Witchcliffe, which has no reticulated water supply or sewerage system.

Pemberton and Manjimup water supplies

Pemberton's town water supply is sourced from Big Brook Dam, on a tributary of Lefroy Brook, as well as a small weir on Lefroy Brook downstream of Big Brook Dam.

Manjimup's water supply comes from Phillips Creek Dam and Scabby Gully Dam. Both are located in the upper Lefroy Brook catchment of the Warren River basin. Due to successive years of low intensity rainfall, these dams have not filled to capacity.

Until recently the Water Corporation proposed to satisfy growth in demand in the medium term (up to 20 years) by diverting a portion of the winter flows in Record Brook to Scabby Gully Dam via a pump-back facility on Record Brook. The focus has now changed and current planning and development approvals are looking at abstraction from the Yarragadee aquifer to satisfy the increased demand. Long-term planning (beyond 20 years) has begun, and will consider a range of options including a combination of both surface water and groundwater sources. Construction of an integrated Manjimup, Pemberton and Northcliffe water supply is being considered.

7.4 Sewerage infill program

In 1994 the state government and the Water Corporation launched an infill sewerage program to provide reticulated sewerage services to most Perth metropolitan residential properties and targeted country towns. The program was designed to:

- protect public water supplies
- protect groundwater resources
- minimise health risks to the community
- protect the environment
- reduce pollutants entering drains, rivers and wetlands
- facilitate the orderly development and redevelopment of land.

The state government has deferred some of the projects (Table 15) until 2013–14 when they will be reviewed.

Table 15 *Water Corporation infill sewerage program*

Catchment	Area	Scheduled completion
Blackwood	Boyup Brook	Deferred – to be reviewed in 2013–14
	Bridgetown	Deferred – to be reviewed in 2013–14
	Nannup	2010
	Margaret River	Deferred – to be reviewed in 2013–14
Leschenault	Australind	2009
	Collie	Deferred – to be reviewed in 2013–14
	Bunbury	Deferred – to be reviewed in 2013–14
Warren	Manjimup	2009
	Pemberton	2009

Source: Water Corporation June 2009 (note: schedule subject to changing priorities)

8 Knowledge investment

Refer to the actions identified in the Strategic directions and actions *document under Theme 7: Involve the community for effective management of regional water resources.*

8.1 Adaptive management

Adaptive management is a tool that is used to learn about a water system. It is an iterative process where management adjusts and responds to threats as new information is gained or from the understanding of why management has succeeded or failed. Importantly, it includes the whole system, that is, the social as well as the ecological or economic systems. As water supply and demand bridge closer, we need to have sound monitoring underpinned by a good understanding of the resource and its dependencies to allow responsive and proactive management. It is about investment in knowledge to build social and ecological system resilience.

An adaptive management approach to water resource management requires ongoing investment in resource investigations to improve the understanding of water systems. Resource monitoring needs to be focused on the resource objectives and the data used to assess how the resource is responding to the management initiatives. Where necessary, management initiatives should be adjusted or adapted to meet the stated objectives. High-quality data through investigation and assessment is needed to assess resource conditions, support numerical modelling efforts and evaluate the effectiveness of management measures. While investigation, assessment and modelling work is needed to help set resource objectives, monitoring and assessment against objectives is the way to maximise use of the water resource while preventing over-use and subsequent impacts. The challenge is to move from a linear investigation approach into a management-feedback-loop approach.

The integrated adaptive management of groundwater and surface water is essential to understand the connections between them and the ecologies that depend on them. Current knowledge is generally poor and we are not well placed to monitor the effects of changes to these connections. To understand whether the health of waterways is being maintained, it is essential to directly monitor the parameters that should be protected, which in this case, are ecological.

Examples of the knowledge investment around environmental water relates to investigations of:

- shallow groundwater systems (saturated and unsaturated zone characteristics and dynamics)
- plant-water relationships and how ecosystems respond to different hydrological regimes such as watertable decline, water quality changes and reduced rainfall
- rainfall runoff modelling to estimate surface water resources.

Environmental water

Adapting to a drier climate raises some important questions about how and what water resource objectives are to be set through the planning process. Ecological water requirements need to be benchmarked to the prevailing climatic and land-use conditions. Depending on the management objectives for each area, ecological water needs may vary through time as climatic conditions vary. Managing a changing ecology will therefore require a better understanding of ecological resilience to ensure transition to new eco-hydrological states. As discussed previously, there is a need to better understand surface water and groundwater connectivity and interactions and ecological dependencies. Decreased water availability through decreased runoff and groundwater recharge means that environmental water needs will change, thus providing some challenges to the Department of Water in managing the south west's water resources and their environmental dependencies.

8.2 Water resource investigations

Groundwater resources

In 2006, the Department of Water undertook a drilling investigation across the eastern Scott coastal plain. The objective was to define the extent of aquifers and develop a more comprehensive monitoring-bore network. This investigation focused on an area where there is increasing water demand from the Yarragadee aquifer for irrigation (Irwin 2007). The monitoring bores observe fluctuations in water levels and groundwater quality on an ongoing basis, and contribute to sustainable management of these resources (Johnson, Commander, O'Boy & Lindsay 2005).

During the same year, the department also completed a drilling program near Cowaramup to assess the potential groundwater resources of the Leederville aquifer.

Future groundwater investigations in the south west are in areas of increased groundwater abstraction and/or where existing groundwater information is insufficient to allow re-assessment of resources under pressure from natural and/or induced causes (Johnson et al. 2005).

In 2008–09, the department undertook preliminary groundwater investigations in the Lesueur Sandstone (to the south of Margaret River) and the Yarragadee aquifer (south-east of Busselton). A new monitoring bore was installed in Bunbury in May 2009 to assess the movement of the saltwater interface.

The department is also compiling the *Southern Perth Basin bulletin,* which should be publicly available in 2010 This publication will describe the hydrogeology and groundwater resources of the Southern Perth Basin and complement the existing publication for the Perth metropolitan area and a future publication for the Northern Perth Basin.

In 2003 the Water Corporation carried out groundwater investigations on the middle part of the Blackwood Plateau, including the recharge zone for the Yarragadee aquifer. Information was incorporated into the South West Aquifer Modelling System

(SWAMS), a numerical model that represents the groundwater flow system. SWAMS is used to predict changes in water levels due to future groundwater abstraction across the south west. It is a regional model providing regional scale predictions and its use for local decision-making is limited.

Surface water resources

In 2005–06 the Department of Water began a four-year project to determine the ecological water requirements, environmental water provisions, sustainable diversion limits, climatic impacts and allocation limits for the Margaret River, Willyabrup Brook, Cowaramup Brook, Chapman Brook, Capel River, Brunswick River and Lefroy Brook catchments.

This project, delivered through the South West Catchments Council (SWCC), aims to:

- determine the environmental, social and economic values of the surface water resources
- assess the quantity of surface water needed to support dependent ecosystems
- determine the extraction limits for consumptive use
- determine current consumptive use and project future demand
- gain an improved understanding of the hydrologic relationships between groundwater and surface water resources.

The program's outcomes will protect these resources from over-allocation and guide the approval of future licences to take and use water in these catchments.

Interaction of groundwater and surface water

The interaction of groundwater and surface water is an important process in some areas of the south west. It is probably best known on the Blackwood Plateau where the Yarragadee aquifer discharges significant volumes of fresh water to the Blackwood River and its tributaries (Milyeannup Brook and Poison Gully) in the form of baseflow, thus improving the water quality. The baseflow maintains perennial flow and important environmental values in the river's tributaries and permanent pools. Such interactions are vital to supporting aquatic ecologies in many waterways, particularly during the summer months, yet we have limited knowledge about the actual hydraulic processes.

The Leederville aquifer also discharges to the Blackwood River between Nannup and Milyeannup Brook and downstream of Layman Brook – supplying baseflow to the river, improving water quality and maintaining permanent pools throughout summer. St John and Rosa brooks and the upper Margaret River are Leederville dependent as well. Many rivers on the coastal plains, such as the Scott and Capel rivers, are also supported by groundwater baseflow.

In addition to the rivers and their tributaries, many surface water features such as lakes and wetlands are groundwater dependent. These include international and nationally important features such as Lake Jasper.

Water interception by plantations

The significance of plantation groundwater-use will be investigated in 2009–10. The investigations will be carried out in areas of the south west where there is competition for water or where plantation water-use may impact on water quality, such as the potential acid sulfate soil areas of the Scott coastal plain. This will involve:

- research to quantify water-use in important water resource management areas where data is unavailable
- spatial mapping of the current extent of established plantations, and development of a database to record and monitor future plantations
- input of newly acquired data into existing groundwater models so that impacts on key environmental assets may be better predicted, especially surface water- and groundwater-dependent ecosystems and in situ social water values.

8.3 Resource condition targets

A key task for the Department of Water in the next five to 10 years is the setting of resource condition targets for the south west's waterways. If protecting the health of fish species in the waterways is an objective, then direct monitoring of the condition of the fish should be the target. Before targets are set, baseline data is needed, the water system's dynamics must be understood and the resource's values and management objectives have to be defined. In most developed areas, it will not be feasible to return waterways to pristine condition. For significantly degraded waterways, a series of interim condition targets may be set and periodically reviewed. These may be adjusted to reflect knowledge gained through practice. In some instances, many decades of management may be required before the desired resource condition is attained.

System models will play a valuable role in determining appropriate management targets and in measuring success. The Department of Water, in partnership with the Department of Agriculture and Food (DAFWA), has developed catchment models for the Geographe Bay, Leschenault and Hardy Inlet catchments. The *Streamflow Quality for Rivers and Estuaries* (SQUARE) model relates land use to nutrient and sediment export, and provides water balance information related to maintaining the system's health. With funding from the South West Catchments Council (SWCC), the department is using the catchment models to quantify the impact of land-use change, a drying climate and management decisions on the waterways and receiving waterbodies of these catchments.

Salinity is a water quality parameter and the Department of Water undertakes salinity recovery in a number of catchments. Salinity recovery plans are being developed for both the Collie and Warren rivers.

In an ideal situation, many different parameters would be monitored to keep the waterways healthy and the water 'useable'. However, it is not always practical or economical to monitor every parameter, hence the setting of resource condition targets is a useful means to monitor waterway health.

8.4 Water resource monitoring

Purpose

Monitoring and evaluation provide the basis for making informed decisions on:

- the condition of water resources and the identification of current and emerging water problems
- surface water and groundwater interactions
- the setting of resource management priorities
- the implementation and ongoing improvement of water management programs
- heath of waterways and ecological status
- the effectiveness of management actions.

Monitoring needs

High quality and timely data are essential for effective water resource management. The Department of Water operates water monitoring networks for surface water and groundwater that are used to record changes and trends in water quality and quantity. Other sources of monitoring data include catchment groups, water service providers and industry.

The existing water monitoring programs provide considerable data but could be strengthened by:

- improving or increasing the collection of flow and nutrient data for decision-making using nutrient modelling, and for determining nutrient loads according to needs
- improving quality assurance procedures, such as sampling and laboratory analyses and the recording of metered water extraction
- ensuring sampling regimes are timely, consistent and sufficiently rigorous for their intended purpose
- ensuring there are sufficient monitoring sites, including reference sites, in areas under significant pressure or where systems are complex or poorly understood
- improving water quality measurement for specific management needs (e.g. data on agricultural nutrients, salinity in waterways, saltwater intrusion/interface)
- ensuring monitoring programs provide sufficient baseline data to determine resource conditions and evaluate the effectiveness of management measures

- increasing biological monitoring for determining waterway health (set up an ecological reference network)
- centralising all monitoring data in the Department of Water's Water Information Network (WIN) database to maintain data integrity and facilitate retrieval
- increasing the public availability of water monitoring information on the department's website
- establishing a clear definition of links between monitoring programs and project and program plans
- improving public reporting on water resource status and trends
- monitoring areas that are predicted to become priority areas and develop capacity to react effectively to changes in pressures
- gaining an understanding of surface water/groundwater interactions by ensuring appropriate and adequate spatial coverage takes place.

8.5 Capacity building initiatives

Capacity building is a holistic approach to knowledge building and sharing, which fosters skills development, competency, innovation and confidence. It is also a means to facilitate network building and training for continuous improvement in water management. Some of the capacity building initiatives in the south west are described below and a list of useful websites are provided in Appendix E.

Agency websites – the Department of Water's website and offices in Bunbury, Busselton and Manjimup offer a wealth of materials on water resources and best-management practices. Other agencies with extensive online materials include the Department of Environment and Conservation (DEC), the Water Corporation, DAFWA and the Department of Health.

Launched in 2007, **New WAter Ways** is a state and local government partnership offering skills and capacity building programs in integrated water cycle management, such as water sensitive urban design (WSUD), for local government engineers and planners and the development industry. It is an umbrella organisation for all WSUD information, designed to gather, organise and disseminate current, relevant tools that help the uptake of water sensitive developments. New WAter Ways provides training, educational site visits of demonstration projects, free networking events with local case studies, and hosting of international and national experts in the range of water sensitive design functions relevant to Western Australia's conditions.

The **Water for the Future** framework is an Australian Government initiative built on four key priorities:

- taking action on a drying climate
- using water wisely
- securing water supplies
- healthy rivers and waterways.

The framework will fund a range of water policy reforms in both rural and urban areas around Australia.

NRM projects – SWCC and its member catchment groups engage in community capacity building through a variety of waterway and riparian zone restoration projects, river action plans and training programs in best-management practices.

The Department of Water coordinates community capacity building through river-restoration training workshops and the river-restoration action team (***River RATs***), which is a communication network for river managers. This network helps various community groups to restore waterways. It includes provision of training packages, technical advice and best-practice guidelines and notes, such as the *River restoration manual*, and helps with river action plans, waterway and foreshore assessments and surveys and waterway restoration works. The network also helps community groups collate and access water monitoring data, which is used to design and evaluate waterway restoration projects.

The DEC-coordinated **Ribbons of Blue/Waterwatch WA** program is an environmental education network aimed at increasing community awareness and understanding about local water quality and taking action for a better environment. The regional program is funded by the Australian Government and coordinated through SWCC, with contributions from the DEC, Department of Water and private companies. Ribbons of Blue is currently based at the Geographe Catchment Council (GeoCatch) office in Busselton. All schools in the region have been involved in Ribbons of Blue to varying degrees since 1995. However, due to changes in priorities, Ribbons of Blue will not be funded past June 2010.

The Water Corporation's **Waterwise Schools** program supports the education of students, families and communities about the need to value, protect and conserve water resources. The program is a long term, whole-of-school approach to water and education. Most importantly, the program tackles real issues facing the community. It promotes behavioural change at the individual and school levels to support water conservation and responsible use of resources. Approximately 30 South West schools are participating in the program. Waterwise schools are listed on the Water Corporation's website.

The **National Irrigation Skills Initiative** – Irrigation Australia Ltd[24] (IAL) offers irrigation industry certification and training programs to help build capacity for efficient irrigation planning, design and installation.

The **Community Water Grants** program is part of the Australian Government's Water Fund. It offers grants to help local community organisations save, recycle or improve the health of their local water resources. In April 2007 the Australian Government announced additional funding of $200 million to extend the program for a further four years, until 2012–13.

24 In 2007 the Australian National Committee on Irrigation and Drainage (ANCID) and the Irrigation Association of Australia merged to form IAL.

South west projects that received funding in 2008 included:

- schools' water efficiency projects (e.g. slow-flow devices, stormwater capture)
- wetland clean-up and rehabilitation
- replacement of turf greens with synthetic greens
- recycling of rainwater, surface water, agricultural runoff and water from industrial sources
- installation of gross pollutant traps, bio-retention systems and native plant species to stop sediments and heavy metals entering a waterway
- installation of rainwater tanks to collect water for irrigation.

Best-management practices

Examples of best-management practice (BMP) guidelines applicable to the south west are:

- *Environmental management guidelines for vineyards* (WRC & DEC 2002)
- *Environmental best management practice guidelines for dairy farming* (Dairycatch 2006).

A variety of other BMP research and/or training programs are also occurring in the south west, such as:

- *Guidelines for management of farmland adjacent to the Busselton wetlands* (AgWA 2002).
- The Blackwood Basin Group's *BestFarms environmental management system*.
- *WineWatch* is developing BMPs for wastewater management for small wineries in the Margaret River area. The project is a collaboration between the Margaret River Wine Industry Association, Curtin University, the Cape to Cape Catchments Group and GeoCatch.
- The DAFWA-administered *Greener Pastures* program is a five-year intensive-farming systems project to help farmers make smarter use of nutrients, especially nitrogen. Greener Pastures investors include DAFWA, Dairy Australia, Western Dairy, Land & Water Australia, CSIRO and the Western Australian Chemistry Centre.

9 Integrated land-use planning and water management

Refer to the actions identified in the Strategic directions and actions *document under Theme 4: Facilitate water sensitive development.*

Integrated land-use planning and water management is the process by which people at various levels of the land and water planning decision-making process implement water sensitive design and achieve integrated water cycle management. It is the coordinated consideration and implementation of water resource management requirements with other land-use planning requirements. To ensure positive water management outcomes, water resources are best considered at the following levels of land planning:

- broad (e.g. strategic and structure planning, regional schemes, town planning schemes)
- local (e.g. subdivisions, developments, detailed local structure plans and town planning schemes).

In the past, a lack of integrated land and water planning has been one of the major barriers to effective water management. Integrated land-use planning and water management is necessary for positive water resource management outcomes through total water cycle management. It is a key tool in facilitating state and regional development.

9.1 The need for integrated management

Groups and individuals in the south west have raised concerns and identified issues that suggest the need for stronger links between land-use planning, water, catchment and natural resource management, and biodiversity protection. Progress is being made in the region to ensure that these efforts are complementary and recognise the importance of total water cycle management. This progress includes:

- greater consideration in planning processes of both land and water planning objectives and management issues
- the adoption of partnership models that facilitate greater integration across agencies and between public and private-sector interests
- the adoption of total water cycle management, allowing greater integration across different areas of water resource management (such as drainage and water allocation) and across land, water and natural resource management activities.

Integrated land-use planning and water management will be implemented via the following mechanisms:

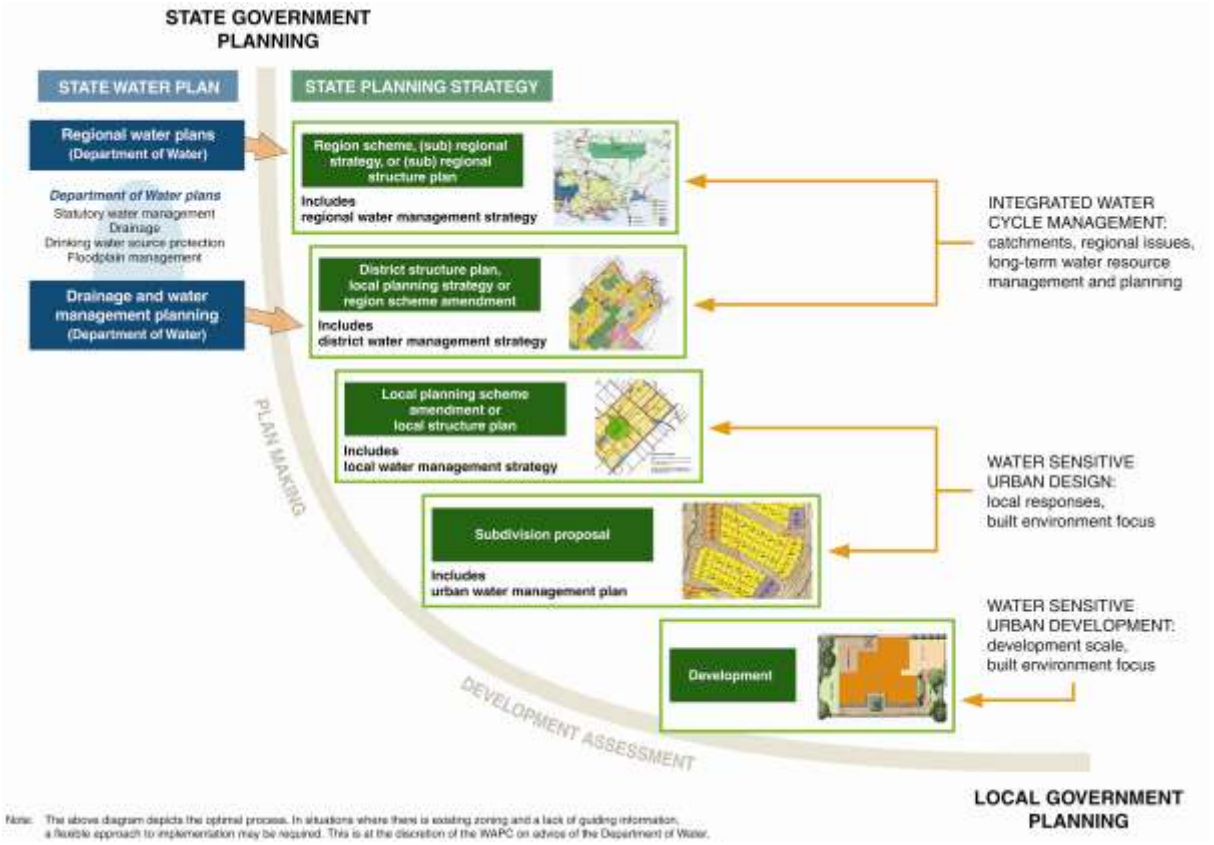
Urban water management

In Western Australia the integration of land and water planning is implemented through *Better urban water management* (WAPC 2008). This document was prepared to guide the implementation of *State planning policy no. 2.9: Water resources* (refer to Section 9.3) and was developed through a collaboration between the Western Australian Planning Commission, Department of Planning (DoP), Department of Water, the Western Australian Local Government Association (WALGA) and the Australian Government's Department of the Environment, Water, Heritage and the Arts.

Better urban water management (WAPC 2008) is designed to facilitate better management and use of urban water resources by ensuring an appropriate level of consideration is given to the total water cycle at each stage of the planning process. The document describes how water resources should be considered at each land-use planning stage. It identifies actions, investigations and agencies responsible for provision of particular water resource information. Water resource information derived at each planning stage is used to inform the subsequent planning stage.

This integrated land and water planning framework will deliver a change in traditional management responses to water resource management issues by facilitating coordinated actions by stakeholders at all levels of the land development process.

Figure 21, which depicts the optimal process, shows the hierarchy of decision-making in urban water management. It recognises regional, district, local and lot scales, although the actual scales in urban water management can be highly variable.



Source: *Better urban water management* (WAPC 2008)

Figure 21 *Integrated land and water planning via the* Better urban water management *framework (WAPC 2008)*

There are some limitations to the framework. Recent research (Kitsios & Kelsey 2008) has suggested that even if water sensitive urban design is implemented, an increase in nutrient loads from each developed area may still occur, largely as a result of landowners using fertiliser on their lawns and gardens. This increase in nutrients to waterways is of concern, particularly because many areas proposed for urban expansion are in recovery catchments where water quality is already poor and large nutrient-load reductions are necessary to protect the waterways.

Since the release of the framework, many developers in both urban and industrial settings have adopted the framework's principles and are linking water availability, drainage and waterways management into their decisions (e.g. Ambergate development; Kemerton and Shotts industrial estates).

Statements of planning policy (SPP)

Stronger links are being formed between land and water planning through the WAPC's statements of planning policy (SPPs) under the *Planning and Development Act 2005*. The SPPs with the strongest ties to water resource management are:

SPP no. 2 *Environment and natural resources policy* (2003)

SPP no. 2.5 *Agriculture and rural land use planning* (2002)

SPP no. 2.6 *State coastal planning policy* (2003)

SPP no. 2.7 *Public drinking water source policy* (2003)

SPP no. 2.9 *Water resources* (2006).

The WAPC and local governments must give due regard to the provisions of SPPs when preparing or amending town planning schemes and when making decisions on planning matters. The State Appeal Tribunal is also required to take account of SPPs when determining applications for review.

SPP no. 2.9: Water resources (WAPC 2006) guides the planning for, and protection and management of, surface water and groundwater catchments. This includes consideration of the availability of water and waterways management, wetlands and their buffers, waterways and their estuaries and foreshore areas, as well as implementation of total water cycle management principles in the land-use planning system.

The policy provides specific advice on addressing water resource issues in land planning through:

- planning strategies and structure plans
- town planning schemes and their amendments
- subdivision and development applications.

Priority agricultural areas

The *State water strategy: irrigation review final report* (Government of Western Australia 2005) noted that areas suitable for future irrigated agriculture needed to be identified through strategic and integrated land and water resource planning. The review nominated the Department of Agriculture and Food (DAFWA) as the lead agency to champion the need for dedicated irrigated agricultural precincts in the land-use and water planning system.

At a conceptual level, DAFWA has identified areas of the south west with potential state or regional agricultural significance.[25] Agricultural priority management areas are included in *SPP no. 2.5: Agriculture and rural land use planning* (WAPC 2002), however these were identified without an evaluation of water availability. These areas will now be the focus of detailed investigations by DAFWA to identify agricultural areas of state or regional significance. Examination of long-term water availability and management will be included as factors in determining the viability and long-term sustainability of agricultural areas. While the long-term availability of water cannot be guaranteed, water trading may be a practical option in highly allocated areas to

[25] An agricultural area of state or regional significance is one that contains productive agricultural land that is suitable for the sustainable development of key or specialised agricultural uses that are of significant economic or social value to the state or a particular region.

secure water supplies. Figure 22 displays the existing and potential agricultural priority management areas in the south west.

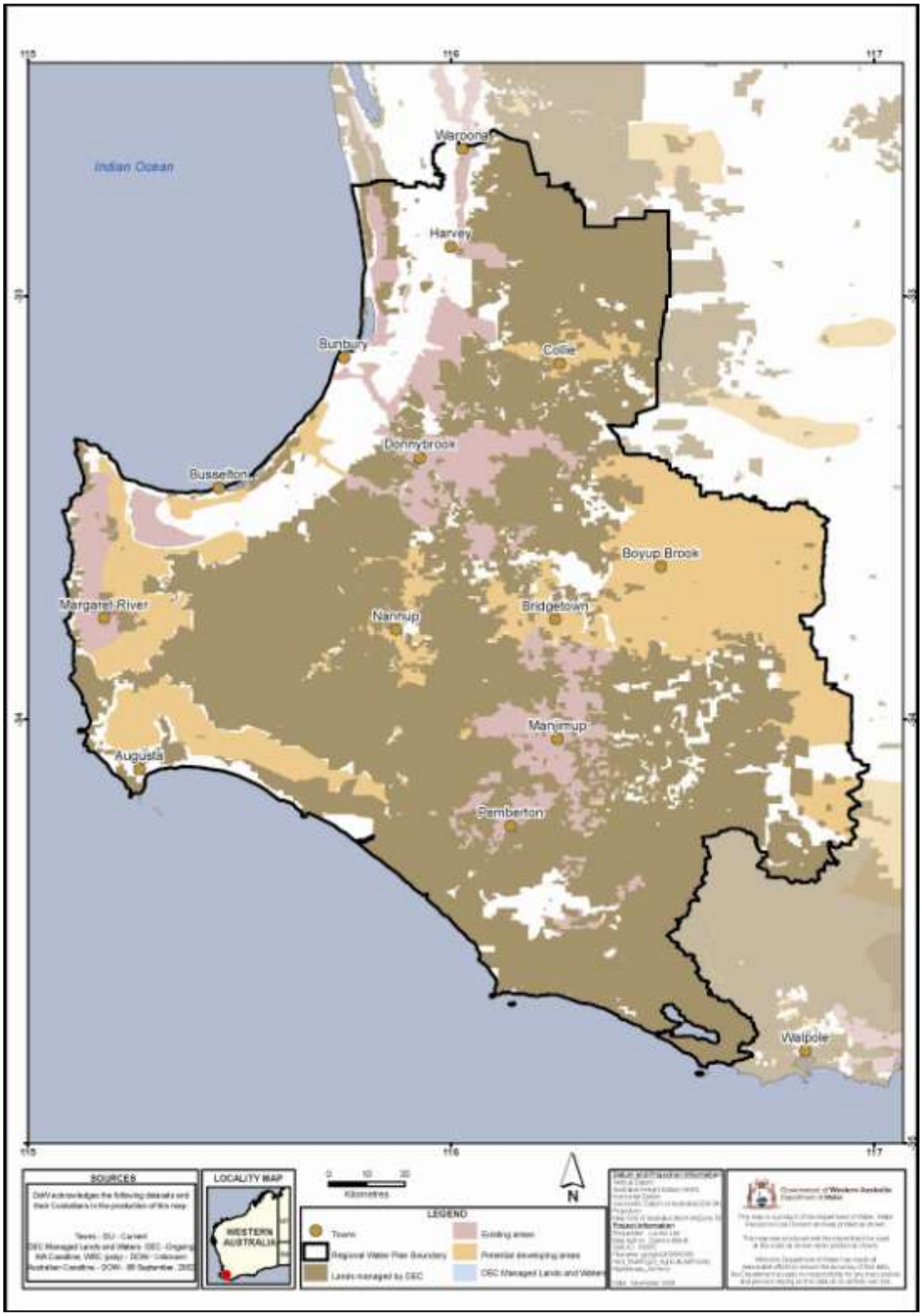


Figure 22 *Agricultural priority management areas*

Plantation forestry

Plantation forestry is both a land-use planning and water resource planning issue. The WAPC adopted the *Farm forestry policy* in 2000, and revised it as *Planning bulletin no. 56* in 2003 (WAPC 2003b). The policy was developed before water interception by tree plantations emerged as a water management issue. In 2008, the state government released *Western Australia's strategy for plantations and farm forestry 2008–2012* (Government of Western Australia 2008). This strategy identifies the importance of close integration between water management and land-use planning with regard to plantation development in the state and supports research into the relationship between trees, water yield and water quality. There is ongoing community concern that impacts on water availability have not been quantified such that decision makers (e.g. local governments) cannot make informed decisions on development approvals.

Presently in Western Australia there is no legal regulation of water interceptions by changes in land use, such as the establishment of commercial plantations. With the region's communities and plantation forestry industry, the Department of Water is consulting on the industry's interception of water with a view to developing a robust and workable interception policy. The department has set out the high-level principles that will guide further policy development. The policy will identify the circumstances under which regulation of water interception/use by plantation forestry operations may be required and will be developed under the following principles:

- Where new large-scale plantation forestry and/or the expansion of existing forestry operations contribute positively to the environmental objectives of the south west, such as reducing the impacts of salinisation, the regulation of water interception will generally not be required.
- In areas of high allocation, where there is a demonstrated or potentially significant negative impact on the environment and/or existing water users, water interception by new plantation forestry and/or the expansion of existing forestry operations should be regulated.
- Water management and regulatory decisions will be based on an understanding of the total water balance, considering impacts on ecological, social, cultural and economic values.
- The assessment of values and their interaction will use the best-available science including the scaling up from plot scale or small catchment areas to groundwater or surface water management areas, taking into account basin-scale effects.
- The determination of 'significant impact' in identified priority management areas will have regard to both the historical and more recent and evolving water balances.
- Water interception by existing plantations will be taken into consideration when the water balance is determined. However, under proposed policies they will generally not be regulated for the life of the plantation.

- Farm forestry[26] will normally be excluded from regulation where it is generally restricted to a maximum of 10 per cent of the farm property area.

Farm dams

The number of farm dams has grown dramatically in the South West region during the past 20 years. Farm dams intercept and store overland flows and can affect the amount of water available for other uses. Where a water resource is nearing or has reached its limit of extraction, the amount of water intercepted by on-stream and off-stream farm dams needs to be accounted for in water allocation plans. The state's water reform process is examining how best to manage water interception. This includes determining what regulations should apply.

Investigations into the impact of farm dams on key surface water systems in the south west, including the Capel and Margaret rivers and the Wilyabrup, Cowaramup and Chapman brooks, indicate that a change to the regime and volume of flow has the potential to alter the ecology and natural values of the waterways. In particular:

- total annual flows are reduced
- the magnitude of flow in summer is reduced but the duration of summer flows generally increases
- the magnitude and duration of winter high flows is unaffected
- the seasonality of flows is affected as dams are filling
- in the most severely affected catchments, the onset of early winter flows, which are important for relieving stress at the end of summer, are delayed
- there is a greater impact in drier years.

Many small farm dams are also used to supply properties with water for non-intensive stock and domestic use. Analysis of farm dam mapping has indicated that the largest dam volumes associated with stock and domestic purposes within the region are between 5000 and 8000 kL.

The department is continuing to investigate the impact of dam size and density on streamflow as well as account for dam interception in the catchment water balance and allocations, as outlined in the *Whicher area surface water allocation plan.*

9.2 Role of South West Catchments Council

The South West Catchments Council (SWCC) promotes and coordinates the effective conservation and sustainable use of land, water, biodiversity, coastal and marine natural resources through effective planning and management, research, monitoring and community development. It implements natural resource

26 Farm forestry refers to planted forestry within a property where the main product of a farm is not the planted forest, but occurs as part of the mix of farming activities, where the forest area is a small proportion of the farm area (10 per cent of a farm area is sometimes quoted). Plantations that cover a small proportion of an individual farm area within a catchment could be defined as insignificant and hence excluded from licensing. The actual proportion should be related to the catchment area as well as the farm area.

management (NRM) policies and programs in the South West NRM region. This includes the *State Salinity Strategy*, *National Action Plan for Salinity and Water Quality*, and *Caring for our Country* objectives.

The SWCC delivers NRM services in partnership with local, state and federal governments and private-sector interests. Constitutionally, there are six subregional groups in the SWCC region: Blackwood Basin Group, Cape to Cape Catchment Group, Geographe Catchment Council (GeoCatch), Leschenault Catchment Council, Peel-Harvey Catchment Council and Warren (Southern Forests Landcare). All of the subregional groups work together in partnerships with the SWCC, state agencies, local governments, community groups and local communities to meet the latest set targets. Limited funds in 2009 will, however, reduce the contribution by subregional groups.

The government agencies represented on the SWCC are the Department of Water, Department of Environment and Conservation (DEC), DAFWA, DoP, South West Development Commission, Peel Development Commission and WALGA.

9.3 Water quality improvement initiatives

Coastal Catchments Initiative

The *Coastal Catchments Initiative* is an Australian Government program undertaken in collaboration with state government agencies including the Department of Water, DoP, WALGA and the Water Corporation. The initiative's goal is to achieve significant reductions in the discharge of pollutants to coastal 'hot spots' around the country that require special attention and care in the form of management plans and water quality improvement plans. Two of the state's three hot spots are in the South West. They are the Peel-Harvey estuarine system, and the Vasse-Wonnerup Estuary and Geographe Bay.

Water quality improvement plans have been prepared by the Environment Protection Authority for the Peel-Harvey Estuary, and by the Department of Water for the Vasse-Wonnerup systems, consistent with the *Framework for marine and estuarine water quality protection* (Environment Australia 2002). These plans identify the environmental values of waterways and the management actions to protect those values. The plans also identify the most cost-effective and timely projects for investment by all parties, including federal, state and local governments, and community and environment groups.

Vasse-Wonnerup Estuary and Geographe Bay

The water quality problems of the Vasse-Wonnerup Estuary and Geographe Bay have been the subject of numerous studies and programs. For instance, the *Lower Vasse Cleanup Program* began in 2006 and is a partnership involving GeoCatch, the Shire of Busselton and the Department of Water, with strong community involvement. Program activities include Vasse River foreshore rehabilitation, catchment waterway revegetation, dredging to remove nutrient-rich sediment, best-management practices

for stormwater, Phoslock™ trials,[27] public education campaigns and monitoring. Due to the complexity of the water quality problems and the amount of degradation, significant improvements will take a number of years to be realised.

The water quality improvement plan for the Vasse-Wonnerup Estuary and Geographe Bay was completed in May 2009 and included an ecological character description for the wetlands. This is critical to meeting Australia's international obligations under the Ramsar Convention on Wetlands. Water quality will be improved by reducing agricultural sources of nutrients and implementing water sensitive urban design in partnership with local government and industry. In 2005, as a tool to assist in planning land-use change in this catchment for both urban and rural areas, the Department of Water published the *Geographe Bay coastal catchment – land capability assessment for managing the impact of land use change on water resources* (Deeley 2005).

Scott River and Hardy Inlet

The Scott coastal plain: a strategy for a sustainable future (DAFWA 2001) identified drainage issues and nutrients leaching from agricultural activities as key water management concerns and a constraint on future agricultural development on the Scott coastal plain. Apart from significant water quality and water allocation issues there are also pressures to expand agriculture (e.g. dairy farming) and tree plantations.

Building on the strategy's findings, the Blackwood Basin Group is working towards implementation of a water quality recovery program in the lower Blackwood catchment, with the Scott River and Hardy Inlet as the foci. Completion of the program will depend on funding. The program employs a partnership model involving government agencies (including DAFWA and the Department of Water), the Lower Blackwood Land Conservation District Committee (LCDC) and landholders. The collaborative partners are currently seeking funds to develop a water quality improvement plan for the Hardy Inlet, which will set water quality targets and recommend management actions to improve water quality.

Leschenault Inlet

The Leschenault Catchment Council and the Department of Water are developing a water quality improvement plan for the Leschenault estuary system. The plan will:

- incorporate the values of riverine and estuarine waters
- recognise the water quality issues threatening these values
- establish resource condition targets
- review and establish river flow objectives for maintaining ecosystem health
- identify a suite of management areas to achieve water quality improvement.

[27] Use of a modified clay product to reduce phosphorus availability in the system, thereby limiting algal blooms.

10 Community and stakeholder engagement

Refer to the actions identified in the Strategic directions and actions *document under Theme 7: Involve the community for effective management of regional water resources.*

Finding and implementing solutions to the south west's water resource issues will require collaboration between multiple government and non-government organisations. In a broad sense, all members of the south west community hold an interest in the outcomes of water resource management. The Department of Water is committed to providing the community with appropriate opportunities for meaningful participation in water management and planning.

Effective engagement with the wider community and specific interest groups is necessary to ensure the department's management of water resources is achieved in an equitable and efficient manner. Some concerns that were raised by members of the South West Water Forum included:

- a lack of certainty that water users and community members generally would be heard and addressed in ongoing planning activities
- a desire to see the department extend its level of interaction with specific groups
- a desire to understand sectoral concerns and to work collaboratively on issues.

The department has developed a regional community engagement framework that will support ongoing discussions about issues such as:

- development of whole-of-water-cycle planning, including water management and allocation plans
- integrated water and land development across the region
- further use of recycled water
- development of appropriate industry water-use efficiency plans
- further use of recycled water.

There are two broad categories covered within the community engagement framework:

- the community in general terms
- key water stakeholder groups.

Even though mechanisms of engagement will differ for each category, there is a need to address both in an integrated manner, as they complement each other.

10.1 Wider community engagement mechanisms

Most residents of the south west are not members of particular interest groups directly involved in water resource management issues. Nonetheless, this wider community needs to be kept informed of developments in water resource management and understand ways to participate if they wish. Mechanisms for regular dissemination of information could include:

- media releases on important activities
- newspaper articles
- radio announcements for meetings and information
- posters and brochures distributed to high-turnover community outlets
- community information sessions on the science and management of water resources.

10.2 Consulting with key stakeholders

The Department of Water seeks to consult, engage and interact effectively with all industry and community interest groups. The department will use a variety of mechanisms to inform key stakeholders and water users. Where specific sections of the community are, or will be, directly impacted by the department's management of water resources, or may be in a position to influence or contribute to the department's planning processes, there will be a clear and open process to ensure that these groups are consulted an appropriate manner.

Key aspects of the community engagement framework include:

- development of networks and relationships with water users and groups to strengthen regular and ongoing involvement and consultation about water resource management and planning and other water issues for the South West region
- overseeing department-instigated committees to ensure they continue to develop and remain relevant as forums for two-way interaction between the department and water users
- development of links with media, key peak bodies and other organisations to provide outlets for regular and appropriate dissemination of departmental information to the wider community.

In 2008 the department reviewed all existing advisory committees in the state as part of the process whereby legislative and regulatory functions previously established under the *Water and Rivers Commission Act 1995* were transferred to the Department of Water. Its purpose was to ensure the department maintains a flexible, comprehensive and open engagement approach to all water users as it continues its legislative and regulatory reform program and maintains its statewide operations.

10.3 Key stakeholders

Key stakeholders identified in the South West region are:

- Department of Water advisory committees
- mining industry
- licensed groundwater and surface water users
- local water user groups
- Indigenous groups
- environmental groups
- local governments
- relevant community and peak industry groups
- state government agencies
- irrigation cooperatives
- water service providers
- locally and regionally based politicians.

(See Appendix B for all the government agencies with an interest in water management and services in the south west).

10.4 Aboriginal engagement

Effective and meaningful engagement by the Department of Water with Aboriginal communities is a major issue. Building on previous engagement activities in the region, the department arranged three workshops in partnership with the South West Catchments Council and South West Aboriginal Land and Sea Council. These workshops were designed to identify Aboriginal values, issues and needs and to provide some understanding of the actions needed in the *South West regional water plan*.

The '*Aboriginal heritage and Native Title guidelines for on-ground works'* have been developed to support the department's policy for engaging with Aboriginal people, and aim to assist staff in assessing and meeting the department's policies and statutory requirements under the *Native Title Act 1993* (Cwlth) and the *Aboriginal Heritage Act 1972* (WA).

These guidelines primarily deal with on-ground works that fall under the following statutory functions of the Department of Water:

- management and monitoring
- river care
- emergency responses.

10.5 South West Water Forum

The Department of Water established the South West Water Forum (SWWF) in 2006 to provide an avenue for key water users to advise on priority regional water issues, policies and implementation of the *South West regional water plan*.

As the Plan has now been completed, the SWWF has been 'absorbed' into the overall community engagement framework for the region and will no longer exist in its original form or intent. The SWWF invited members are listed in Appendix A. Engagement of the community through the SWWF has been crucial to the development of this Plan.

Appendix 1 — South West water forum invited members

Aqwest – Bunbury Water Board
Busselton Water
Chamber of Commerce and Industries (SW Chapter)
Chamber of Minerals and Energy (SW Chapter)
CSIRO Water for a Healthy Country – South West
Fruit Growers Association Western Australia
Forest Industries Federation of Western Australia
Harvey Water
Indigenous NRM Facilitator (SWCC)
Irrigation Association of Australia
Leeuwin Environment Centre
Pastoralists and Graziers Association
Peel-Harvey Catchment Council
Preston Valley Irrigation Cooperative
Potato Growers of Western Australia Inc.
Shire of Nannup
Shire of Augusta-Margaret River
Shire of Donnybrook-Balingup
Shire of Manjimup
South West Catchments Council
South West Development Commission
South West Environment Centre
South West Land and Sea Council
South West Regional Recreational Fishing Advisory Committee
Trees South West
Urban Development Institute of Australia
Vegetables Western Australia
Western Australian Farmers Federation
Warren Water Advisory Committee
Water Corporation (SW Region)
Whicher Water Resources Management Committee
Wine Industry Association

Appendix B – Agencies with interests in water management and services in the South West

Organisation	Responsibilities/roles
Department of Planning (DoP)	Strategic and statutory land planning; infrastructure planning.
Department of Agriculture and Food Western Australia (DAFWA)	Promotion of sustainable agricultural practices; natural resource management (NRM).
Department of Environment and Conservation (DEC)	Management of conservation reserves; protection and management of biodiversity, including wetlands; regulation of wastewater discharges from prescribed premises; administration of the *Environmental Protection Act* and native-vegetation clearing regulations.
Department of Fisheries Western Australia	Conservation and management of fish resources; supervision of aquaculture.
Department of Health (DoH)	Management of compliance with drinking water quality guidelines.
Department of Indigenous Affairs (DIA)	Maintenance of Aboriginal sites register.
Department of Industry and Resources (DIR)	State economic development; administration of State Agreement Acts.
Department of Water (DoW)	Water resources policy, planning, management and regulation; water-industry policy; liaison with key interest groups, e.g. the SWCC.
Economic Regulation Authority (ERA)	Licensing of water service providers; inquiries into water pricing and other matters.
Environmental Protection Authority (EPA)	Environmental impact assessment; environmental protection policy; state-of-the-environment reporting.
Forest Products Commission (FPC)	Harvesting and selling forest products from state-owned native forests and plantations.
South West Development Commission	Promotion of sustainable regional development in the South West.
Western Australian Local Government Association (WALGA)	Acting as peak industry body for local governments in Western Australia; administration of New WAter Ways program.
Western Australian Planning Commission (WAPC)	Setting of overarching policy for land planning in Western Australia.

Appendix C – Salinity status of South West waterways

Salinity water quality guidelines

(from National Health and Medical Research Council & the Natural Resource Management Ministerial Council 2004)

Salinity (mg/L TDS[28])	Water quality
< 500	Fresh
500–1000	Marginal
1000–2000	Brackish
2000–5000	Moderately saline
5000–10 000	Saline
10 000–35 000	Highly saline
> 35 000	Hyper saline

Salinity status of South West waterways

Basin	Waterway	Station	Salinity status
Shannon River	Deep River	606–001	Fresh
	Noobijup Brook	606–004	Saline
	Shannon River	606–185	Fresh
	Weld River	606–195	Fresh
	Gardner River	606–218	Fresh
Warren River	Warren River (Wheatley Farm)	607–003	Moderately saline
	Warren River (Barker Rd Crossing)	607–220	Marginal
	Perup River	607–004	Moderately saline
	Tone River	607–007	Moderately saline
	Lefroy Brook	607–022	Fresh
	Wilgarup River	607–144	Marginal
	Dombakup Brook	607–155	Fresh
Donnelly River	Barlee Brook	608–001	Fresh
	Carey Brook	608–002	Fresh
	Donnelly River	608–151	Fresh
	Fly Brook	608–171	Fresh
Blackwood River	Balgarup River	609–005	Moderately saline
	Northern Arthur River	609–010	Moderately saline
	Blackwood River (Winnejup)	609–012	Moderately saline
	Arthur River	609–014	Saline

[28] TDS = Total dissolved salts

Basin	Waterway	Station	Salinity status
	Beaufort River	609–015	Saline
	Blackwood River (Hut Pool)	609–019	Moderately saline
	Coblinine River	609–021	Highly saline
Busselton Coast	Margaret River	610–001	Fresh
	Vasse River	610–003	Fresh
	Wilyabrup Brook	610–006	Fresh
	Margaret River North	610–008	Fresh
	Capel River	610–010	Fresh
Preston River	Preston River	611–004	Fresh
	Ferguson River	611–007	Fresh
	Thomson Brook	611–111	Fresh
Collie River	Collie River East Tributary	612–001	Moderately saline
	Collie River (Mungalup Tower)	612–002	Brackish
	Bingham River	612–014	Fresh
	Batalling Creek	612–016	Saline
	Brunswick River	612–022	Fresh
	Camballan Creek	612–025	Moderately saline
	Collie River (South Branch)	612–034	Brackish
	Collie River East Tributary	612–230	Saline
Harvey River	Harvey River (Dingo Road)	613–002	Fresh
	Bancell Brook	613–007	Fresh
	McKnoes Brook	613–018	Fresh
	Harvey River (Clifton Park)	613–052	Fresh
	Clarke Brook	613–146	Fresh

Appendix D – Water Corporation water supply dams

Water Corporation water supply dams

River system	Dam name	Storage capacity	Primary uses	Towns / schemes	EWRs defined
Harvey	Samson Brook	7993 ML	Drinking water	IWSS	
	Waroona Dam	14 930 ML	Irrigation and recreation		
	Stirling	53 769 ML	Drinking water	IWSS	Yes
	Harvey Dam	56 441 ML	Irrigation and recreation		Yes
	Logue Brook	24 321 ML	Irrigation and recreation	Harvey Water Irrigation	
	Drakes Brook Dam	2290 ML	Irrigation and recreation	Harvey Water Irrigation	
Capel	Kirup	60 ML	Drinking water	IWSS	
Collie	Mungalup Dam	681 ML	Drinking water	Collie	
	Harris	72 000 ML	Drinking water	Great Southern	
	Wellington Dam	184 916 ML	Irrigation and recreation	Harvey Water	Yes
Margaret	Ten Mile Brook	1691 ML	Drinking water	Margaret River town water supply scheme	
Preston	Glen Mervyn Dam	2054 ML	Irrigation and recreation	Preston Valley Irrigation Cooperative	
Blackwood	Nannup (Tanjannerup)	156 ML	Drinking water	Nannup	
	Hester Dam	118 ML	Drinking water	Hester	
	Boyup Brook	129 ML	Drinking water	Boyup Brook	
	Millstream Dam	452 ML	Drinking water	Bridgetown regional water supply scheme	
	Dumpling Gully No 1	95 ML	Drinking water	Greenbushes and Balingup	
	Dumpling Gully No 2	98 ML	Drinking water	Greenbushes and Balingup	
	Balingup	61 ML	Drinking water	Balingup	

River system	Dam name	Storage capacity	Primary uses	Towns / schemes	EWRs defined
Warren	Phillips Creek Dam	Not determined	Drinking water	Manjimup	
	Manjimup	1581 ML	Drinking water	Manjimup	
	Big Brook Dam and Lefroy Brook Weir	627 ML	Drinking water and recreation	Pemberton	
	Quinninup	713 ML	Drinking water	Quinninup	
Donnelly	None	N/A	N/A	N/A	N/A
Shannon	None	N/A	N/A	N/A	N/A

Appendix E – List of useful websites

Program / Initiative	Website
Department of Water	www.water.wa.gov.au/regionalplanning
Australian Bureau of Statistics	http://abs.gov.au/websitedbs/D3310114.nsf/home/Census+data
Stormwater management manual for Western Australia	http://stormwater.water.wa.gov.au
Western Australian Government response to a blueprint for water reform in Western Australia	http://portal.water.wa.gov.au/portal/page/portal/PlanningWaterFuture/WaterReform/BlueprintWaterReform/GovernmentResponse
Framework for marine and estuarine water quality protection	www.environment.gov.au/coasts/pollution/cci/framework/index.html
About water trading	www.harveywater.com.au/water_trading.asp?watertradingid=2
Climate Change Australia	www.climatechangeinaustralia.gov.au/resources.php
Five Star Plus program	www.5starplus.wa.gov.au
New WAter Ways	www.newwaterways.org.au
Water for the Future framework	www.environment.gov.au/water/action/index.html
Waterwise Schools program	www.watercorporation.com.au/ education/index_schools.cfm
Waterwise on the Farm program	www.waterwisewaysforwa.com.au
ICLEI Water Campaign	www.iclei.org/index.php?id=6112
National Irrigation Skills Initiative	www.irrigation.org.au
Community Water Grants program	www.communitywatergrants.gov.au
BestFarms environmental management system	www.bestfarms.com.au
Greener Pastures program	http://wwwtest.agric.wa.gov.au/PC_91778.html?s=0
Indian Ocean Climate Initiative (IOCI)	www.ioci.org.au

Acronyms and abbreviations

ARI	Average return interval
ASS	Acid sulfate soils
ANZECC	Australia and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
BMP	Best-management practice
BRS	Bureau of Rural Sciences
BUWM	Better urban water management
CARR	Comprehensive, adequate and representative reserve
DWSPPs	Drinking water source protection plans
GWAs	Groundwater areas
IOCI	Indian Ocean Climate Initiative
IWSS	Integrated water supply scheme
LCDC	Lower Conservation District Committee
NOID	Notice of intention to drain
NWI	National Water Initiative
PDWSA	Public drinking water source areas
PDWSPP	Public drinking water source protection plan
River RATS	River restoration action team
RNE	Register of National Estate
REU	Resource Economics Unit
SPP	Statement of planning policy
SQUARE	Streamflow Quality for Rivers and Estuaries
SWALSC	South West Aboriginal Land and Sea Council
SWAMS	South West Aquifer Modelling System
SWCC	South West Catchment Council
SWMA	Surface water management areas
SWWF	South West water forum
TDS	Total dissolved solids
WAEs	Water access entitlements
	Waterways Health Sub-strategy

WHSS	Wastewater treatment plants
WWTPs	

Government agencies	Bureau of Meteorology
BoM	Department of Agriculture and Food Western Australia
DAFWA	Department of Environment and Conservation
DEC	Department of Education and Training
DET	Department of Mines and Petroleum
DMP	Department of the Premier and Cabinet
DPC	Department of State Development
DSD	Department of Health
DoH	Department of Water
DoW	Department of Planning
DoP	Environmental Protection Authority
EPA	Economic Regulation Authority
ERA	Water and Rivers Commission (now Department of Water)
WRC	Western Australian Planning Commission
WAPC	

Other organisations	

BBG	Blackwood Basin Group
ICLEI	International Council for Local Government Initiatives
LGAs	Local Government Authorities (see WALGA)
PHCC	Peel-Harvey Catchment Council
SWCC	South West Catchment Council
WALGA	Western Australia Local Government Association
WA	Water Corporation
WSPs	Water service providers (Water Corporation, Aqwest, Busselton Water)

Glossary

abstraction	The withdrawal of water from any groundwater resource ('extraction' can also be used but this generally refers to the withdrawal of water from a surface water resource).
allocation limit	Annual volume of water set aside for consumptive use from a water resource.
aquifer	A geological formation or group of formations capable of receiving, storing and transmitting large quantities of water.
baseflow	The component of streamflow supplied by groundwater discharge.
bore	An opening in the ground, normally a vertical hole drilled in soil or rock, made or used to obtain access to groundwater. This is equivalent to the description of a 'well' in the *Rights in Water and Irrigation Act 1914.*
dewatering	Removing groundwater to facilitate construction or other activity. It is often used as a safety measure in mining or as a preliminary step to resumption of development in an area *(Rights in Water and Irrigation Act 1914)*.
discharge	The water that flows from an aquifer to the ground surface, such as a spring. This includes water that seeps onto the ground surface, evaporation from unsaturated soil, and water extracted from groundwater by plants (evapotranspiration) or engineering works (groundwater pumping).
domestic bore	A bore used for non-commercial purposes, such as providing the in-house and household garden watering requirements.
ecological water requirements (EWRs)	The water regime needed to maintain the ecological values of water-dependent ecosystems at a low level of risk.
eutrophication	A natural process of accumulation of nutrients leading to increased or abnormal aquatic plant growth in wetlands, rivers, harbours and estuaries. Human activities contributing fertilisers and high-nutrient wastes can speed up the process, leading to algal blooms and deterioration in water quality.
environmental water provisions (EWPs)	The water regimes that are provided as a result of the water allocation decision-making process, taking into account ecological, social, cultural and economic impacts. They may meet in part or in full the ecological water requirements.
evaporation	Loss of water from the water surface or from the soil surface by vaporisation due to solar radiation.
evapotranspiration	The combined loss of water by evaporation and transpiration. It includes water evaporated from the soil surface and water transpired by plants.
groundwater	The water that occurs in pore spaces and fractures in rocks

	beneath the ground surface. See also ‘aquifer’
groundwater area	An area proclaimed under the *Rights in Water and Irrigation Act 1914* for the purposes of licensing and managing water-use.
hydrogeology	The hydrological and geological science concerned with the occurrence, distribution, quality and movement of groundwater, especially relating to the distribution of aquifers, groundwater flow and groundwater quality.
interception	When a number of land use change activities, mostly unlicensed, have the potential to intercept significant volumes of surface water and/or groundwater now and in the future, including in-stream farm dams, off-stream farm storages, stock and domestic bores, and large scale, commercial plantation forestry.
licence	A formal permit that entitles the licence holder to ‘take’ water from a watercourse, wetland or underground source.
recharge	Water that infiltrates the soil profile to reach the watertable and replenish an aquifer.
salinity	The measure of total soluble salt or mineral constituents in water. Water resources are classified based on salinity in terms of total dissolved solids (TDS) or total soluble salts (TSS). Measurements are usually in milligrams per litre (mg/L) or parts per thousand (ppt). It can also be measured as electric conductivity (EC) as µS/cm.
social value	A particular in situ quality, attribute or use that is important for public benefit, welfare, state or health (physical and spiritual).
subarea	A smaller area determined by the Department of Water within a proclaimed area used for water allocation planning and management purposes. The boundaries of these are based on the location of the water resource.
surface water	Water flowing over or held in streams, rivers and wetlands on the surface of the land.
sustainability	Meeting the needs of current and future generations through integration of environmental protection, social advancement and economic prosperity.
trade	Sale of part or all of a licensed entitlement/s, by a licensee (vendor) to a second party (purchaser).
water efficiency	The minimisation of water-use through adoption of best management practices.
water entitlement	The quantity of water that a person is entitled to take on an annual basis in accordance with the *Rights in Water and Irrigation Act 1914* through a licence.
water reserve	An area proclaimed under the *Metropolitan Water Supply Sewerage and Drainage Act 1909* or *Country Areas Water Supply Act 1947* to allow the protection and use of water on or under the

	land for public water supplies.
wetland	For the purposes of this plan (unless otherwise specified), the Department of Water adopts the Ramsar Convention on Wetlands definition of a wetland as an area that is permanently, seasonally or intermittently waterlogged or inundated with water that may be fresh, saline, flowing or static, including areas of marine water of which the depth at low tide does not exceed six metres.

Disclaimer

All maps in this publication were produced by the Department of Water with the intent that they be used for the *South West regional water plan* at the scale of 1:1 400 000 when printing at A4.

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

The department acknowledges the following datasets and their custodians in the production of these maps:

Dataset name – Custodian acronym – Metadata date

Acid Sulphate Soil Risk Map – DEC – September 2006

DEC Managed Lands & Waters – DEC – July 2005

Drainage Districts – Water Corporation – 2007

Existing Agricultural Management Areas – Dept. of Ag. – November 2002

Groundwater Areas – DoW – October 2007

Groundwater Subareas – DoW – January 2007

Hydrographic Catchments Basins – DoW – June 2007

International – Ramsar – DEC – February 2002

Lands Managed by DEC (formerly CALM) – Dept. of Ag. – June 2002

Leederville Aquifer Licensed Bores – DoW – July 2006

Local Government Authorities – Landgate – March 2001

Main Roads – Landgate – June 2004

Major Rivers – DoW – November 2007

Minor Rivers – DoW – November 2007

National – Directory of Important Wetlands – Environment Australia – August 2001

National – Register of the National Estate – Dept. of Ag. – November 2004

National – Wild Rivers – DoW – July 2006

Potential/Developing Agricultural Management Areas – Dept. of Ag. – November 2002

Proclaimed Rivers – DoW – July 2006

Proclaimed Surface Water Areas – DoW – October 2007

Public Drinking Water Supply Areas – DoW – July 2007

Rainfall Isohyets – DoW – September 2005

Regional Water Plan Boundary – DoW – June 2007

Significant Streams – DoW – November 2007

Superficial Aquifer Licensed Bores – DoW – July 2006

Surface Water Management Areas – DoW – October 2007

SWMA Boundary Value – DoW – October 2007

Towns – Geoscience Australia – December 2002

Western Australia Coastline – DoW – July 2006

All maps have been produced using the following data and projection information:

Vertical Datum: AHD (Australian Height Datum)

Horizontal Datum: GDA 94 (Geocentric Datum of Australia 1994)

Projection System: Map Grid of Australia (MGA) 1994 Zone 50

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