Department of Water
Government of Western Australia

Managing water in the **Upper Collie**

A status report on surface and groundwater management

October 2007

Department of Water
Government of Western Australia

The Department of Water manages Western Australia's water resources. We do this by informing the government and the community on the availability, quality and use of water.

It is our duty to ensure that Western Australia's water resources are managed to balance the needs of water users with those of the environment.

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Front cover photographs: Waterfall pool on the Collie River and the Harris Reservoir.

Foreword

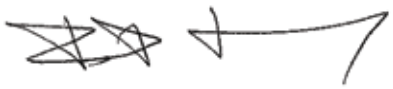
The Department of Water has been actively measuring, modelling and managing water resources in Collie for many years.

People from both the South West Region and the Perth office of the Department have provided valuable input to improve the way water resources in Collie are managed. This includes a significant initiative to restore water quality in the catchment.

As we move into a new era of water reforms and statutory water management planning, it is important that we review and reflect on the work that has been done to date, as well as confirm our direction for the future. This *Managing water in the Upper Collie* report is a significant step in developing our Upper Collie water management plan.

This report synthesizes our understanding of the water resources, the background work we have completed, and the information we have gathered as part of developing the Upper Collie water management plan.

We hope you find it a useful reference document.



R D Hammond
A/Director General

Contents

Figures

Tables

1

How to use this document

What area in Collie does this report cover?

Chapter 2 describes the location of the Upper Collie surface and groundwater areas.

How are water resources managed in Collie?

Chapter 3 outlines the framework that controls water management in Western Australia, and locally in Upper Collie.

Chapter 4 describes water management planning and why we are completing a water management plan for the Upper Collie surface and groundwater areas.

What water resources does Collie have and who uses them?

Chapter 5 outlines the surface water resources of the Upper Collie and the major types of surface water use. This includes descriptions of the Wellington and Harris reservoirs.

Chapter 6 describes the groundwater resources of the Collie groundwater area, and the main types of use within the Coal Basin. This includes information on coal mining, dewatering and power generation.

What important values are there in the Upper Collie?

Chapter 7 describes what a water-dependent value is and details the primary ecological and social values in the Upper Collie.

How are the impacts of water use managed?

Chapter 8 outlines how impacts of water use are managed and the Collie River pool supplementation program.

2

The Upper Collie surface and groundwater areas

Location

The Upper Collie surface and groundwater areas are located around 200 kilometres south of Perth, in the south west of Western Australia.

The Upper Collie surface water area covers the reaches of the Upper Collie catchment, above Wellington Reservoir, and encompasses over 2,800 km^2 of land. The Collie River is the catchment's major river and it flows across the Swan Coastal Plain to discharge into the Leschenault Estuary, immediately north of Bunbury (Figure 1).

The Upper Collie groundwater area covers the groundwater of the Collie Coal Basin. This significant groundwater resource sits in the centre of the Upper Collie catchment. Groundwater from the Collie Basin discharges, at various points, into the Collie River and its tributaries.

What are surface and groundwater management areas?

The Department of Water manages Western Australia's water resources by issuing licences to take water. Under the *Rights in Water and Irrigation Act 1914*, areas need to be proclaimed before the Department can issue licences. Surface and groundwater management areas are boundaries the Department of Water establishes, so it can proclaim the area and manage resources through issuing licences.

We decide the boundaries for surface and groundwater management areas based on detailed investigations of the resources (such as the rivers or aquifers); the type and extent of water use; and our understanding of the system's hydrology or hydro-geology.

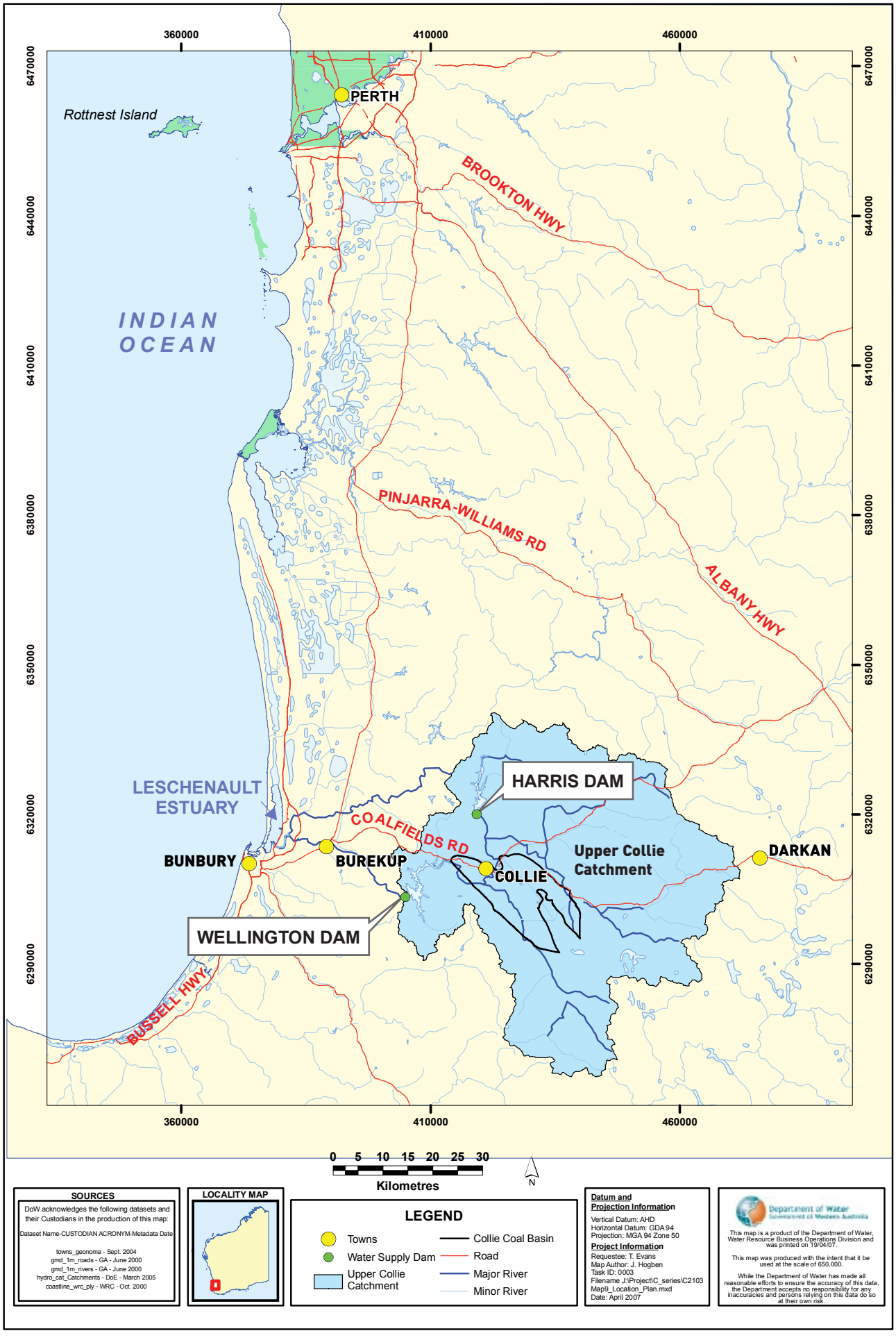


Figure 1. Location of the Upper Collie surface and groundwater areas

3

How water resources are managed in the Upper Collie

Proclamation and water licensing

The Department of Water regulates water use in proclaimed areas of Western Australia through the *Rights in Water and Irrigation Act 1914* (RiWi Act). This legislation enables the Department to issue licences to take water or to interfere with a watercourse. The Upper Collie surface and groundwater area covers two proclaimed areas – the Collie groundwater area and part of the Collie irrigation district.

The Collie groundwater area was proclaimed on 17 June 1977 (Figure 2). As at August 2007, there were 18 licences to abstract groundwater from the management area.

The Collie River irrigation district was proclaimed on 25 September 1931 (Figure 3). As at August 2007, there were 14 licences to take surface water from the management area.

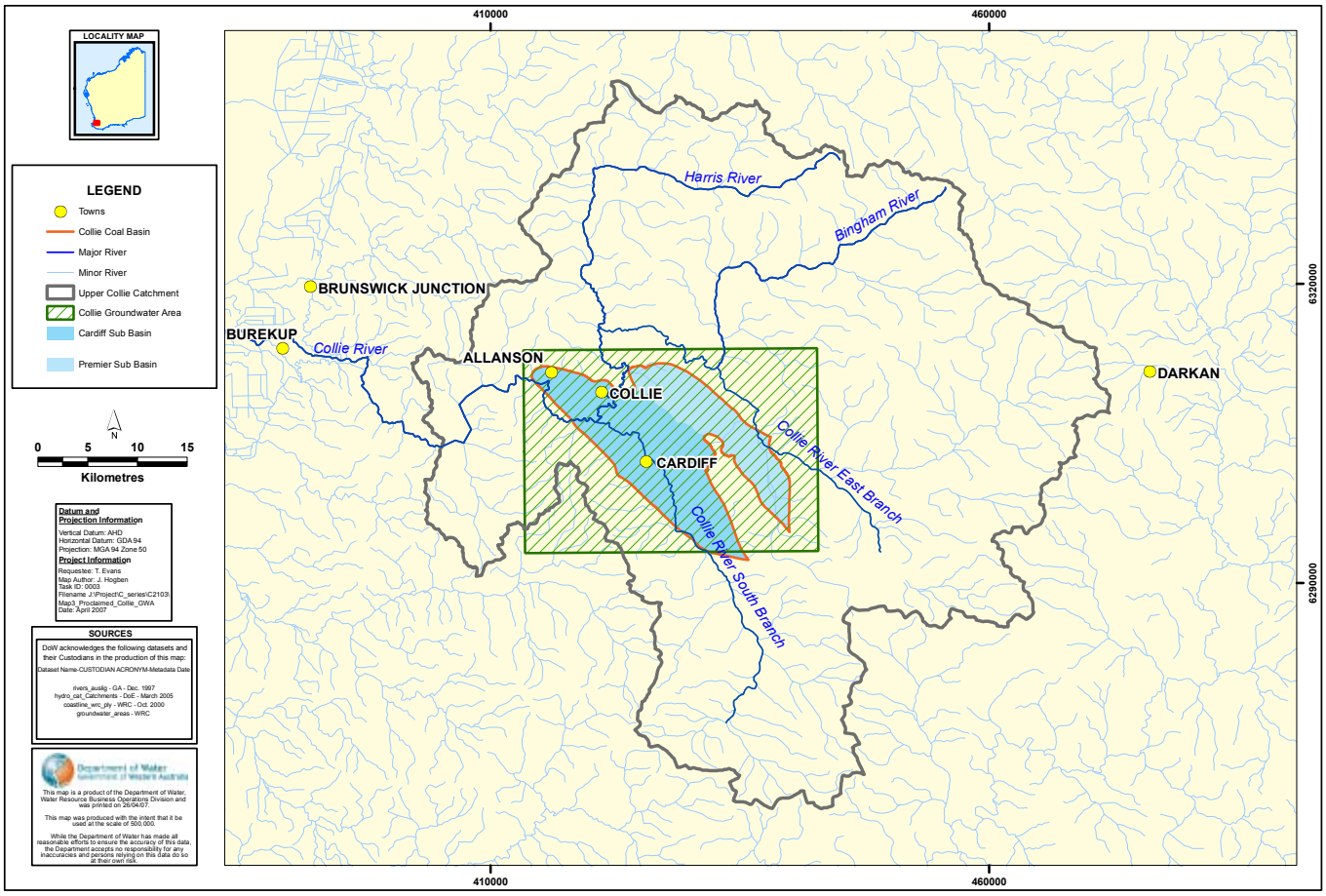


Figure 2. The proclaimed Collie Groundwater Area (overlying the Collie Coal Basin)

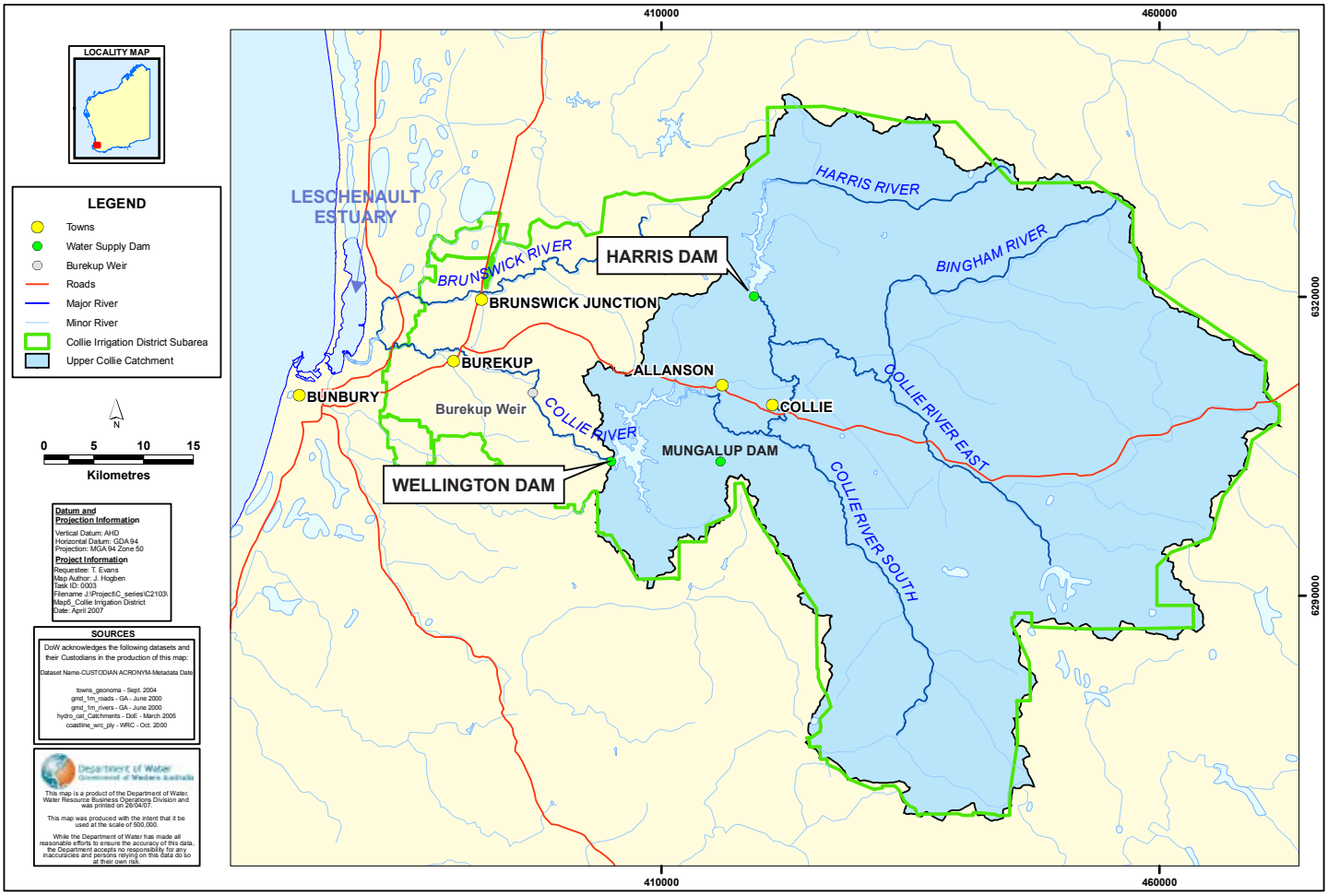


Figure 3. Proclaimed area of the Collie Irrigation District (covering both Upper and Lower Collie catchments)

Water licensing is also guided by national and state management frameworks, including the *State Water Plan*. Locally, water management has been guided through the groundwater management principles developed by the Collie Water Advisory Group (1996 and 1999).

Since the late 1970s, surface water management in Collie has been driven largely by the need to restore water quality in the catchment. Following extensive land clearing, parts of the Collie River became saline due to the increase in annual salt load to the river. The Department of Water has undertaken major initiatives, including the Collie River east branch diversion project, to reduce salinity within the river and restore Wellington Reservoir to fresh water status.

More information on salinity management in the Collie catchment can be sourced from the Department of Water's Salinity and Water Recovery Branch or see Salinity under the Water Management section on our website www.water.wa.gov.au

State agreements

There are legislative requirements that may impact on water allocation and management, under a number of state agreement acts.

The Government of Western Australia has made previous commitments to industries that require long-term certainty, allowing water to be abstracted for major resource developments, such as coal mining.

In the Collie area, the *Collie Coal (Griffin) Agreement Act 1979* and the *Collie Coal (Western Collieries) Agreement Act 1979*, provide legislative direction for coal companies (Griffin Coal and Wesfarmers Premier) to abstract and use groundwater in the Collie Coal Basin. The agreements also cover, to some extent, the provision of mine dewater for power industry use by Verve Energy.

The *Alumina Refinery (Worsley) Agreement Act 1973* binds the state to allocate water from the Wellington Reservoir to Worsley, if there is water available. However, Worsley Alumina has not applied for an actual water entitlement from the Wellington Reservoir at this stage.

Water management principles

The Collie water advisory group (CWAG) produced two Collie water resource strategies, in 1996 and 1999, which set out management goals and principles for the Upper Collie.

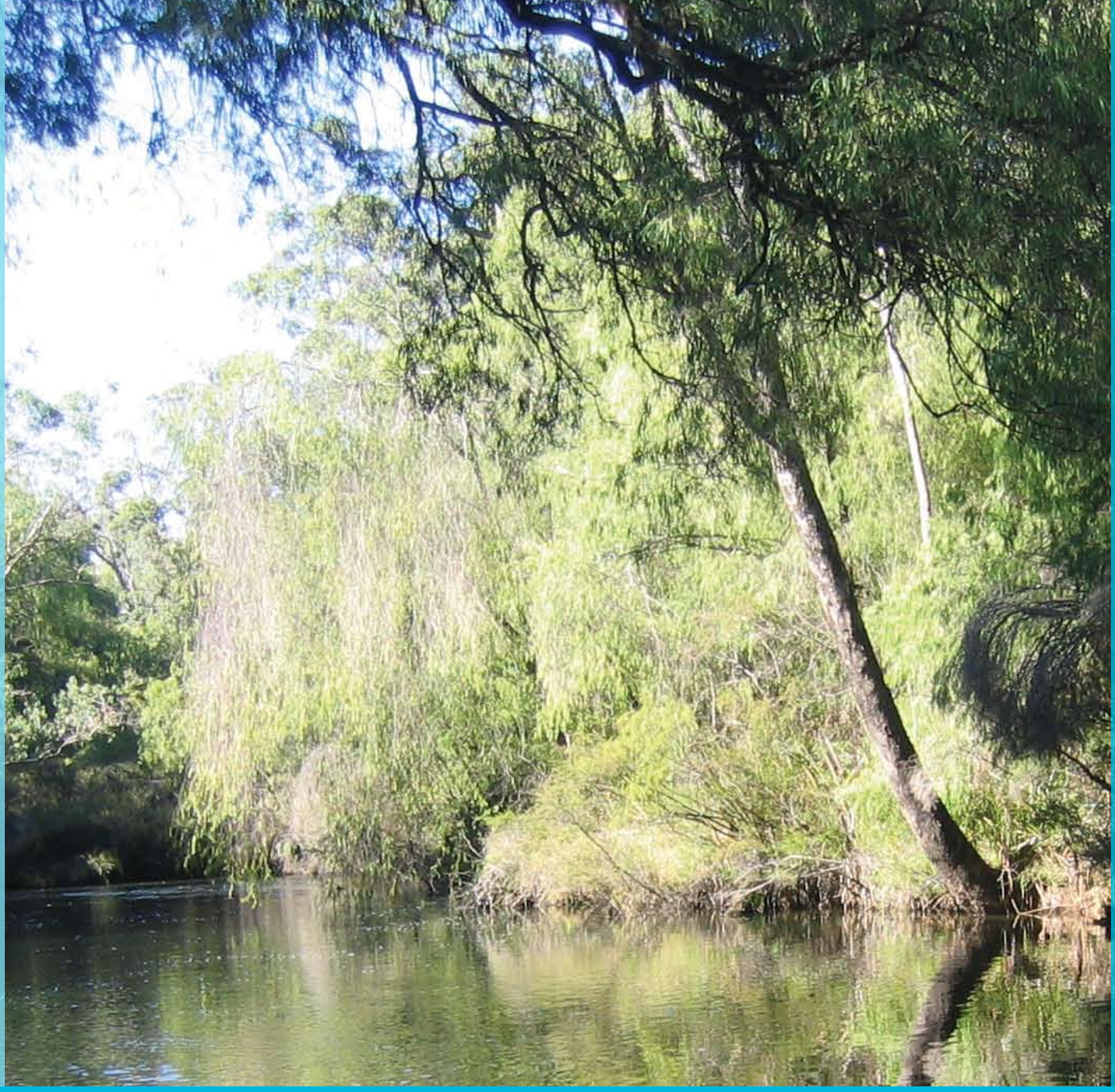
These principles have provided guidance for groundwater management over the past 10 years. Principles relating to minimising groundwater abstractions, facilitating groundwater recovery (in the Cardiff sub-area), and meeting regional water needs, have generally been implemented.

Since these principles were developed, water resource management in the catchment has evolved and new issues have emerged. These include: the proposed expansion of the coal industry; the deregulation of and proposed new power industries; high competition for mine dewater; recognition of climate variability; growing demand for public water supply; and the saline stream diversion.

Reform of current water management legislation and new overarching state water management principles have evolved through the *State Water Strategy* (2003), *State Water Plan* (2006) and the National Water Initiative (2006).

How is the Department improving its water management in Collie?

The Department of Water is developing an Upper Collie surface and groundwater management plan, due for public comment in December 2007. The plan will define principles that address water management issues in Collie. Plan rules and policies will cover new state-wide water management objectives, including efficient water use, fit-for-purpose use, and managing the impacts of use on other values.



The plan will prescribe the amount of water available for use from each resource, as well as the rules and policies to guide how the water is allocated, accessed and used.

The Department of Water will review the 2007 plan and update with a statutory water management plan, due in 2011. The Upper Collie statutory water management plan will take into account new water reform legislation (due in 2008), and be a legally binding document for water management in the Upper Collie.

Public drinking water source areas

The Upper Collie surface water area is also a proclaimed public drinking water source catchment under the *Country Areas Water Supply Act 1947* (CAWS Act). This proclamation relates to the protection of public drinking water source areas to ensure the availability of good quality drinking water.

This report, and the Upper Collie water management plan, does not deal with the water source protection issues, such as defining priority protection areas or policy relating to recreation in public water supply reservoirs.

Further information on drinking water protection can be sought from the Department's Water Source Protection Branch or see Drinking Water under the Water Management section on our website www.water.wa.gov.au

4

Water management and allocation planning in Upper Collie

The Department of Water is currently developing a water management plan for the Upper Collie surface and groundwater areas. The plan will cover the Upper Collie River, the Harris River, the Bingham River and their tributaries, as well as the groundwater resources in the Collie Coal Basin.

The water management plan will: provide a management framework defining water management objectives; define the amount of water available on a yearly basis from each water resource (allocation limits); set the rules of access to water; and define water licensing policies.

Why develop a water management plan for Upper Collie?

Water allocation planning is an important part of assessing how much water is available compared to what the demands are, and what needs to be preserved for the environment.

Water allocation planning in the Upper Collie is a priority given the impact of drying climate on surface and groundwater yields and the increasing water demand for power generation, coal mining and public water supply.

The Upper Collie water management plan will provide guidance for proponents and other interested parties as to how much water is available for use and what policies, rules and regulations will apply.

Water planning timetable

Table 1. Stages of the Upper Collie water management plan

Stage	Jan/ Feb 2007	Mar/ Apr 2007	May/ Jun 2007	Jul/ Aug 2007	Sep/ Oct 2007	Nov/ Dec 2007	Jan/ Feb 2008
Information gathering (issue scoping, water use surveys, identify values, resource assessments)							
Plan drafting							
Draft plan released for public comment							

Once we have finalised the 2007 water management plan, we will begin scoping our statutory water management plan. The statutory water management plan will build on a variety of new projects we are completing over the next three years. The projects are designed to improve our understanding of water management in the Upper Collie. The Department of Water has secured funding from the Commonwealth Government under the Water Smart Australia program to complete the Collie statutory water management plan.

The statutory plan will be a legally binding document.

Other water management planning processes

The following plans are being developed in conjunction with the Upper Collie water management plan, and will align with water management principles and policies in the Upper Collie area:

- The South West regional water plan aims to set the broad objectives and targets for the region.
- The South West groundwater areas management plan focuses on the groundwater resources of the region.
- The Pilbara mining policy outlines policy for groundwater abstraction, mine dewatering and dewater use.

Other plans such as drinking water source protection plans, arterial drainage plans and floodplain management plans have been completed for some parts of the region.

Stakeholder and community involvement

We encourage your input to our planning processes and there will be a number of opportunities for stakeholders to provide input into the Upper Collie water management plan.

If you would like to be involved or you require further information, please contact the Department of Water's Bunbury office.

Phone (08) 9726 4111 or
Email: collieplanning@water.wa.gov.au

5

Understanding Upper Collie surface water resources

The surface water resources of the Upper Collie surface water area include the mainstream of the Collie River, the Bingham and Harris rivers and a number of smaller streams.

The Collie and Harris rivers have been harnessed to create the Wellington and Harris reservoirs. Harris Reservoir constitutes a significant public water supply source for the Great Southern towns water supply scheme. The much smaller Mungalup Reservoir supplies the Collie townsite (refer to Figure 4).

Wellington Reservoir was previously used for public water supply. However, since water in the reservoir declined to brackish quality it is not currently used for this purpose. Harvey Water irrigators' cooperative currently holds the largest allocation of water from Wellington Reservoir. Harvey Water releases water from the reservoir which flows downstream to Burekup Weir, south of the reservoir. From Burekup, water is then diverted to a channel that is picked up by irrigators in the Collie irrigation district.

Wellington Reservoir overflowing 2007

Brackish water quality has an impact on Harvey Water's demand for water from the Wellington Reservoir. The Department of Water estimates that fresh water quality will be restored to the catchment in 2015, if the planned salinity recovery program continues.

As well as being used for major water supply reservoirs, water from the Collie, Harris and Bingham rivers, and their tributaries, is stored in private dams or pumped directly for private needs. Private use is mainly for small agricultural holdings, viticulture, and stock and domestic supply.

Surface water sub-areas

To best manage how the resources are used, the Department of Water divides the Upper Collie surface water area into seven smaller surface water sub-areas. The sub-areas are:

- Harris River;
- Lower Harris;
- Bingham River;
- Collie River East Branch;
- Collie River Lower East Branch;
- Collie River South Branch;
- Collie River Central (refer to Figure 4).

We are developing allocation limits for each of these surface water sub-areas as part of the Upper Collie water management plan.

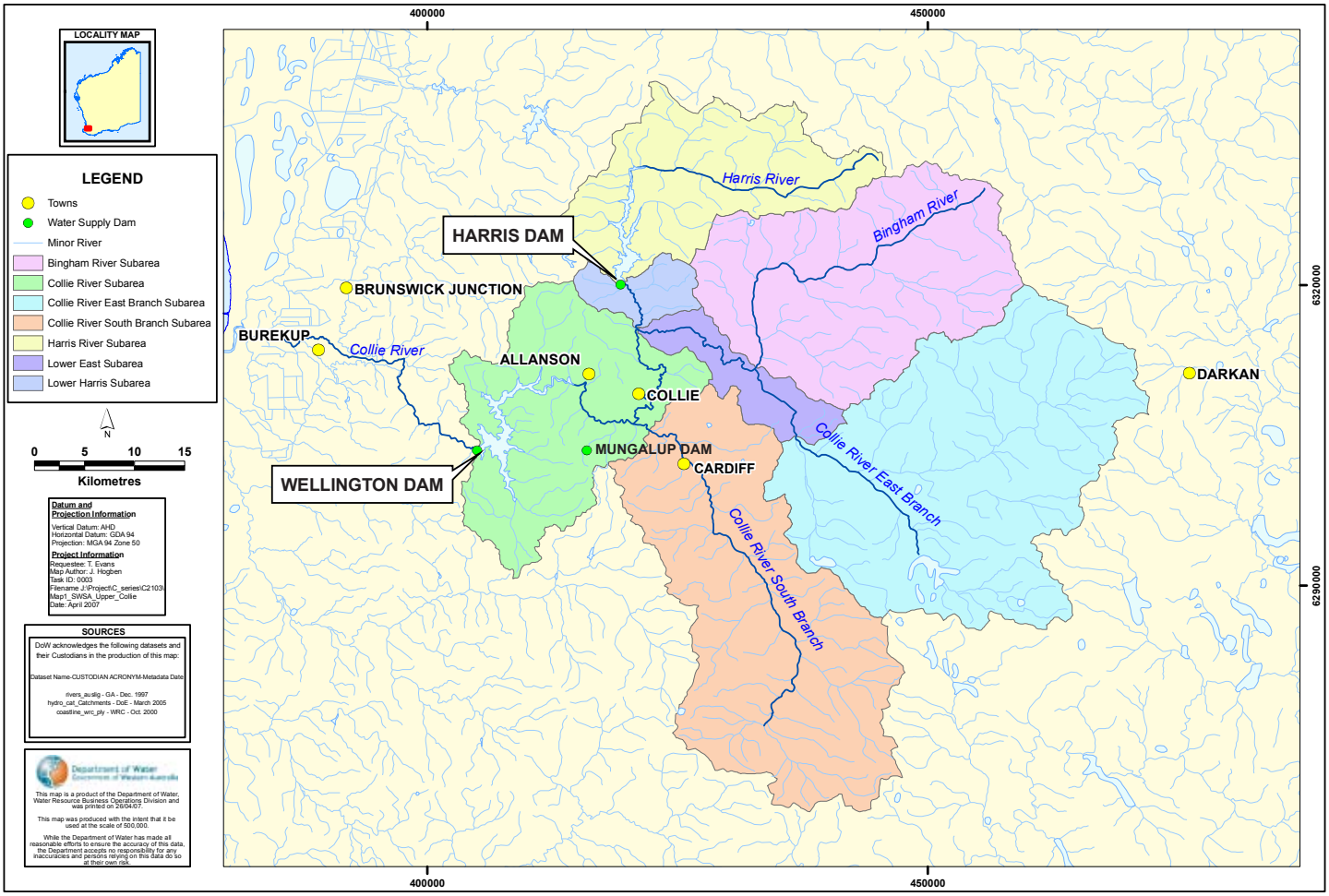


Figure 4. Surface water resources and sub-areas

Water flows and salinity within the Upper Collie

Water flow within the Upper Collie surface water sub-areas is highly seasonal. The Collie, Harris and Bingham rivers are at highest flows over the winter months, when rainfall is highest. During summer, in some parts, the rivers naturally cease to flow and form a series of river pools that are dependent on groundwater.

Since the catchment was cleared, salt from the soil has flowed into the river systems, causing parts of the river to become saline. Saline water flows into the rivers in the eastern and southern portions of the catchment (Collie River east branch sub-area and Collie River south branch sub-area). The Collie River east branch sub-area contributes around 60 per cent of the salt that flows into Wellington Reservoir.

The highest salt load generally enters the rivers following the first rains of the winter.

Collie River South Branch

How does the Department of Water assess how much water there is in the Upper Collie catchment?

In 2003, the Department of Water developed a dynamic hydrologic model of Upper Collie, referred to as the Land Use Change Incorporated CATchment (LUCICAT) model. The LUCICAT model has the ability to generate daily stream flow and salt loads from any nominated point within the Upper Collie river channel and stream network.

The model is calibrated with rainfall and salinity data from 1975-2003. In 2006, we ran the model to generate stream flow and salt loads of each of the seven surface water sub-areas. This flow data tells us how much water flows through each of the surface water sub-areas in any given month. We used this information to assist with setting allocation limits for the sub-areas.

The average amount of water flowing from the sub-areas each year and the salinity of the flow is summarised in Table 2.

The modelled results shows that the average annual flows and salinity, throughout the Upper Collie, are highly variable. The Harris and Bingham rivers contain fresh quality water, while the Collie River east branch contains the highest salt load.

Table 2. Annual flows and salinities of each surface water sub-area (1975-2003)

Sub-area	Mean Annual Flow (Ml/year)	Annual Flow Range (Ml/year)	Mean Salinity (mg/L TDS)	Annual Salinity Range (mg/L)
Harris	19,975	1,414 - 67,333	203	110 – 763
Lower Harris*	7,522	3,212 - 18,426	759	371 - 1,584
Collie River East Branch	29,104	5,117 - 90,929	2,379	783 - 9,244
Lower East	9,389	3,803 - 22,219	1,218	558 - 2,093
Bingham	11,660	1,009 - 40,258	318	132 - 1,495
Collie River South Branch	24,238	4,064 - 77,546	772	221 - 2,646
Collie River Central	50,664	17,360 - 132,277	464	246 - 774

* Contribution from the Lower Harris sub-catchment only, as figures presented do not consider spills and releases from the Harris Reservoir.

The volume of water flowing through the catchment is highly seasonal with most flow occurring during the winter and early spring months (Figure 5). Monthly flows and salinity is, however, highly variable from year to year as shown in Table 2.

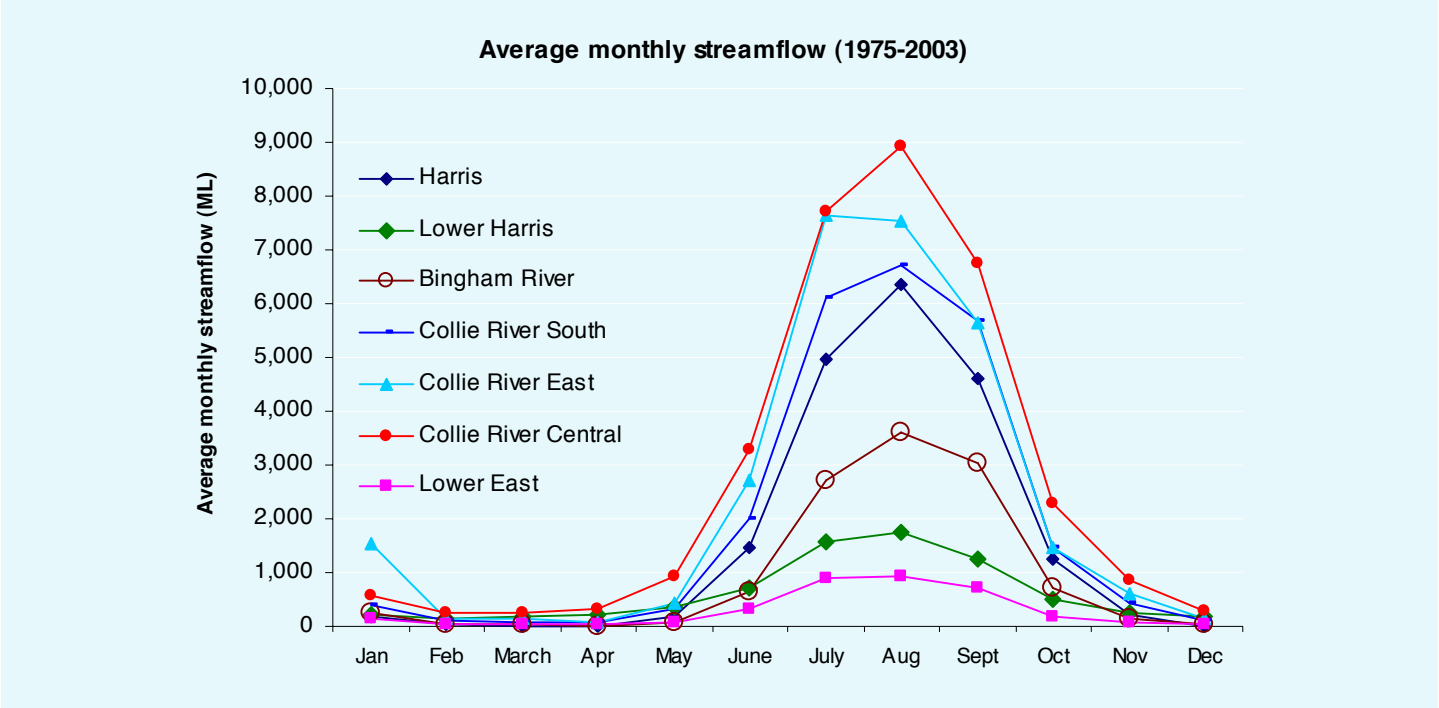


Figure 5. Average monthly stream flow (1975-2003) for each surface water sub-area

When water flows are lowest within the catchment over summer, the salts in the rivers and tributaries are concentrated (Figure 6). The first flows of winter are also relatively high in salt concentration (up to 18,000 mg/L in the East Branch) due to the flushing effect that the rainfall has on the cleared catchment.

As flows increase with winter rainfall, the salt concentrate is decreased since the total volume of water is much higher. However, it is important to note that although salt concentrate (mg/L) is decreased at higher winter rainfalls, the total salt load entering the system is higher.

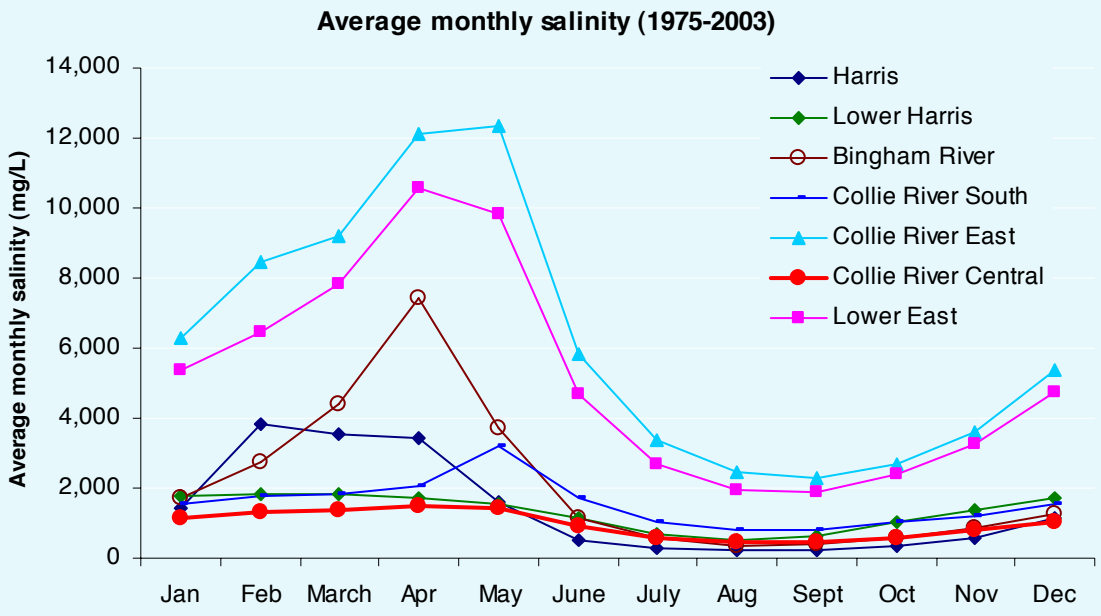


Figure 6. Average monthly salinity (1975-2003) for each surface water sub-area

Surface water use

Surface water resources of the Upper Collie are used to supply both local and regional demand. These include: public water supply, irrigation, viticulture and domestic uses.

Some surface water from the Collie River south branch is also diverted to fill the 'Lake Kepwari' coal mine void. Wesfarmers Premier Coal is currently managing a project to see this mine void transformed into a recreational lake, Lake Kepwari, with tourism facilities.

As at August 2007, over 90 gigalitres of water was allocated from Upper Collie surface water resources. A summary of all surface water use in each of the seven sub-areas is provided in Table 3. The major water users in each sub-area are also provided.

Table 3. Summary of current licensed surface water allocations in each sub-area (as at August 2007)

Sub area	Resource	No. of Licences	Use	Total Licensed Allocations (GL/yr)
Harris	Harris Reservoir	1	Public water supply and local industry. (Note Worsley and Verve Energy are supplied through Water Corporation)	15
Lower Harris	Harris River	1	Irrigation of grapes for viticulture	<1
Collie River East Branch	Collie River	1	Department of Water's saline stream diversion project	3
Lower East	Collie River	0	No licensed allocations	0
Bingham	Bingham River	0	No licensed allocations	0
Collie River South Branch	Collie River	1	Mine void rehabilitation (Lake Kepwari)	3.2
Collie River Central	Wellington Reservoir Mungalup Reservoir Collie River	10	Irrigation and industry (through Harvey water); marron farming; and horticulture	68

Diverting salty surface water flows: salinity recovery project

The Department of Water is managing a project to decrease the salinity of river water entering Wellington Reservoir.

The Department's salinity recovery project includes a trial to divert saline surface flow from the Collie River east branch before it flows through the catchment to Wellington Reservoir. The diversion begins following the first winter rains when the total salt load is highest. When the water becomes too fresh or when the river ceases to flow in late spring, the diversion pumps are switched off closing the diversion season. The saline diversion water is currently pumped to a coal mine void for storage.

The trial started in 2005 and successful results have been achieved during 2005, 2006 and 2007.

In 2005, around one gigalitre of brackish water containing 2,987 tonnes of salt was pumped into the Chicken Creek coal mine void.

In 2006, between May and October, over two gigalitres of brackish water containing approximately 13,000 tonnes of salt was pumped into the mine void. Calculations show that this equated to around a 400 mg/L total dissolved solids (TDS) drop in the salinity of water flowing into the Wellington Reservoir, from the Collie River.

Pumps diverting salty water from the Collie River East Branch

In 2007, as at mid-August, 1.8 GL of water had been diverted, containing nearly 10,000 tonnes of salt.

The Department is planning for a larger permanent diversion under stage two of the Collie Salinity Recovery project. Issues of where to store and how to dispose of diverted water are still being investigated. The Department of Water's Salinity Recovery Branch is currently exploring proposals to desalinate the diverted water for reuse.

Western 5B mine void Lake Kepwari

In 1997, the Western 5B mine was the first group of open cut mines within the Collie Coal Basin to close. The closure involved the filling of six individual mine voids. The largest was Western 5B mine void, which is 70 metres deep, covers an area of around 100 ha and holds approximately 27 GL of water.

The Western 5B mine void is now called Lake Kepwari and is being rehabilitated by Wesfarmers Premier Coal into a premier water ski and water recreation area. Since July 1999, rehabilitation has involved rapidly filling the void with surface water diverted from the Collie River south branch.

Lake Kepwari is now filled. To ensure Lake Kepwari remains at its current water level, it is supplemented with additional water to replace what is lost through evaporation.


Lake Kepwari

Wellington Reservoir

The Wellington Reservoir is the end point of the Collie River Central sub-area.

Wellington Dam was raised to its current level in 1961 when it provided public water supply to the Great Southern towns and irrigation water to the Collie Irrigation District. Land clearing in the eastern and southern portions of the catchment led to salinisation of the landscape and the reservoir was rendered too saline for public water supply. It is now used solely as a source for irrigation water.

In the future, Wellington Reservoir is likely to be used as a public water supply source, once the water quality is returned to fresh.

The annual allocation limit of the sub-area will be determined through the water management plan.

Irrigation water

Harvey Water holds a licence to take up to 68 GL/year from the Wellington Reservoir for irrigation and some industrial use within the Collie Irrigation District. Irrigation demands include pastures, fodder crops, vegetables, grapes and citrus fruit.


Wellington Reservoir

When is water released for irrigation?

Irrigation water is generally released from the reservoir over the warmer months from October to April. Over the past three years, around 52 gigalitres (ranging from 46 to 59 gigalitres) of water has been released annually for irrigation.

The brackish water quality of Wellington Reservoir is a critical issue for the irrigators.

Winter scour policy

To maintain acceptable irrigation water quality, water from the Wellington Reservoir is selectively released (scoured) during winter. Scouring began in 1976 and it involves releasing water from the base of the reservoir after the first saline winter inflows lodge in the base of the reservoir near the dam wall.

Saltier water generally sits as a layer at the bottom of the reservoir. This means that removing water from the lower layer of the reservoir:

1. minimises the loss of relatively fresh water from over-spill and;
2. removes the highest salinity which sits at the base of the reservoir.

The scour releases generally take place between late June and August. Scour volumes and scour rates depend on the salinity of the reservoir, the density of the saline layer in the reservoir, and how full it is. This means the annual scour volume is highly variable and has ranged from about 14 GL to 68 GL since the program began. Over the past three years, around 24 gigalitres (ranging from 14 to 39 gigalitres) of water has been scoured each year.

Is scour water wasted?

Scouring is an important part of managing the salt concentrate of water in the Wellington Reservoir. Scouring the reservoir has resulted in around a five to 10 per cent reduction in the salinity of Wellington Reservoir.

If the salinity of Wellington is not managed, the quality of water will decline further. This means that the water will not be used for irrigation or other potentially valuable uses such as public water supply.

When scour water is released, it provides water to the environment downstream of the reservoir. Canoeists who use the Collie River below the Wellington Reservoir rely on scour water over the winter months to maintain suitable water levels for paddling.

Is any of the water currently released from the Wellington Reservoir for environmental needs?

It is generally considered that water-dependent needs, such as flows suitable for local ecology or water levels suitable for canoeists, are maintained through the release of irrigation water (during the warmer months) and the release of scour water (over the wetter months).

How much water the environment below the reservoir needs, has been roughly established and was considered as part of setting the allocation limit for the Wellington Reservoir (Collie River Central sub-area).

As yet the Department of Water has not set specific release criteria to meet the ecological water requirements below the Wellington Reservoir. In the future, release for environmental water requirements will be defined as conditions on all Wellington Reservoir licences and operating strategies.

Harris Reservoir

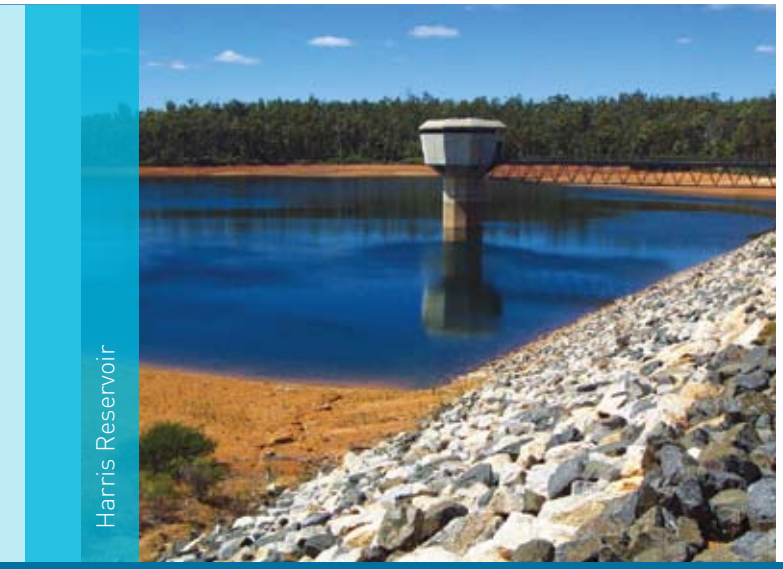
The Harris Dam was constructed on the Harris River in 1991. Harris was developed to meet demand that Wellington Reservoir could no longer supply, due to high salinity levels. The Harris Reservoir sits within a mainly forested catchment and has high quality, fresh water. Harris Reservoir has a storage capacity of 71.5 gigalitres at full supply level.

The Harris Reservoir meets demand for water from Great Southern towns water supply scheme. Occasionally, Harris Reservoir has supplemented local, industrial water demand from Verve Energy and Worsley Alumina. The Water Corporation currently has a licence to abstract 15 GL of water from the reservoir each year.

The Water Corporation is currently considering using Harris Reservoir to hold mine dewater, which may be transferred to the integrated water supply scheme.

Harris Reservoir salinity mitigation release

The Harris Reservoir is upstream of the Collie River. Any water that overflows from the Harris flows into the Wellington Reservoir. The Department of Water, together with the Water Corporation and in agreement with Harvey Water, manages the releases from the Harris in such a way as to decrease the overall salinity of the Wellington Reservoir.



Harris Reservoir

The amount of water released from Harris Reservoir depends on Wellington Reservoir's total storage and salt concentration.

Since 1995, Harris Reservoir releases for salinity mitigation have taken place only in 1998, 1999 and 2003. The Water Corporation estimated that in 2003, the release of around five gigalitres reduced the mean salinity of Wellington Reservoir by 35 mg/L TDS.

Collie River South branch gauging station

In other years, the Water Corporation has reached an agreement with Harvey Water to not make the release, based on factors such as the benefit of the salinity diversion on the Collie River east branch and the water availability in Harris Reservoir.

Mungalup Reservoir

Mungalup Dam was constructed in 1935 on the Mungalup Brook, which is a tributary of the Collie River. Mungalup Reservoir has a storage capacity of 0.68 gigalitres. The reservoir provides public water supply to Mungalup and to the southern part of Collie town, supplementing the supply from Harris Reservoir. The Water Corporation currently hold a licence to abstract 0.5 gigalitres a year from the reservoir.

Surface water stream gauging

Since 1951, the Department of Water has monitored stream flow throughout the catchment via a number of stream gauging stations. Continuous flow data and, in some cases, water quality data are captured and stored in the Department's databases. We have used data from these gauging stations to determine flows and salt loads that discharge from different parts of the catchment. This information has also supported hydrologic modelling of the catchment, including developing LUCICAT.

A summary of current, active surface water gauging stations is provided in Table 4. (over page) You may access stream flow data for each gauging station online through the links provided.

Table 4. Current mainstream surface water gauging stations

Surface water subarea	River	Reference number	Station name	Year installed
Lower East	Collie River East Branch	612001	Coolangatta Farm	1968
Bingham	Bingham river	612014	Palmer	1975
Collie River East Branch	Collie River East Branch	612038	Buckingham Mill	2005
Collie River South Branch	Collie River South Branch	612034	Collie River South Branch	1952
Collie River Central	Collie River	612002	Mungalup Tower	1951
Collie River Central	Hamilton River	612004	Worsley	1972

Primary purpose	Website address
Flow & salinity	http://203.20.251.100/waterinformation/wrdata/FLOW/612001/612001.htm
Flow	http://203.20.251.100/waterinformation/wrdata/FLOW/612014/612014.htm
Flow & salinity from the east branch	http://203.20.251.100/waterinformation/wrdata/FLOW/612038/612038.htm
Flow from the south branch	http://203.20.251.100/waterinformation/wrdata/FLOW/612034/612034.htm
Main inflow and salinity to Wellington Reservoir	http://203.20.251.100/waterinformation/wrdata/FLOW/612002/612002.htm
Flow from high rainfall area of catchment	http://203.20.251.100/waterinformation/wrdata/FLOW/612004/612004.htm

6

Understanding Upper Collie groundwater resources

The major groundwater storage within the Collie groundwater area is the Collie Coal Basin. The Collie Coal Basin is split into two distinct sub-basins: the Cardiff sub-basin and the Premier sub-basin.

Each sub-basin contains seven distinct aquifers which can be grouped into four major groups – the Nakina, Muja, Lower Collie Group and Stockton Group.

Recharge occurs mainly via direct infiltration of rainfall and some infiltration from the Collie River south and east branches. The natural groundwater flow pattern has been altered to flow towards areas of past mining, with some flows discharging into the Collie River south and east branches. The quality of the groundwater is naturally fresh. However, due to disturbance from mining activity, acidity ranges from pH of 2 to 3 near mines to pH of 6 to 7 in other parts. In the basin, water acidity generally increases with depth.

Groundwater use

Groundwater in the Collie Coal Basin is abstracted for mine dewatering as well as supply for power stations, local households and gardens, and irrigation of berries, olives, lawns and school ovals.

There are currently 18 licences to abstract a total of 67 gigalitres a year of groundwater from the basin. Over 99 per cent of this total is for mine dewatering and power station supply.

How much groundwater is in the basin?

In 1999, the Department of Water estimated that there was approximately 7,100 GL of groundwater storage in the basin. The recharge of water to the basin is around 20 GL of water each year.

Table 5. Groundwater sub-areas, aquifer groups and licensed groundwater use (as at August 2007)

Sub area	Aquifer resources	Number of licences	Use	Total allocation (GL/yr)
Cardiff	Nakina, Muja, Lower Collie Group, Stockton Group	13	Power stations, domestic, irrigation, dampening	13
Premier	Nakina, Muja, Lower Collie Group, Stockton Group	4	Mine dewatering, power stations	53
Collie	Fractured Rock	1	Domestic, irrigation	‹1

Minor fractured rock aquifers also exist outside of the Collie Coal Basin boundary, within the Collie groundwater area outlined below. The Department does not recognise these sources as reliable sources of groundwater as they are difficult to locate and yields are generally unreliable.

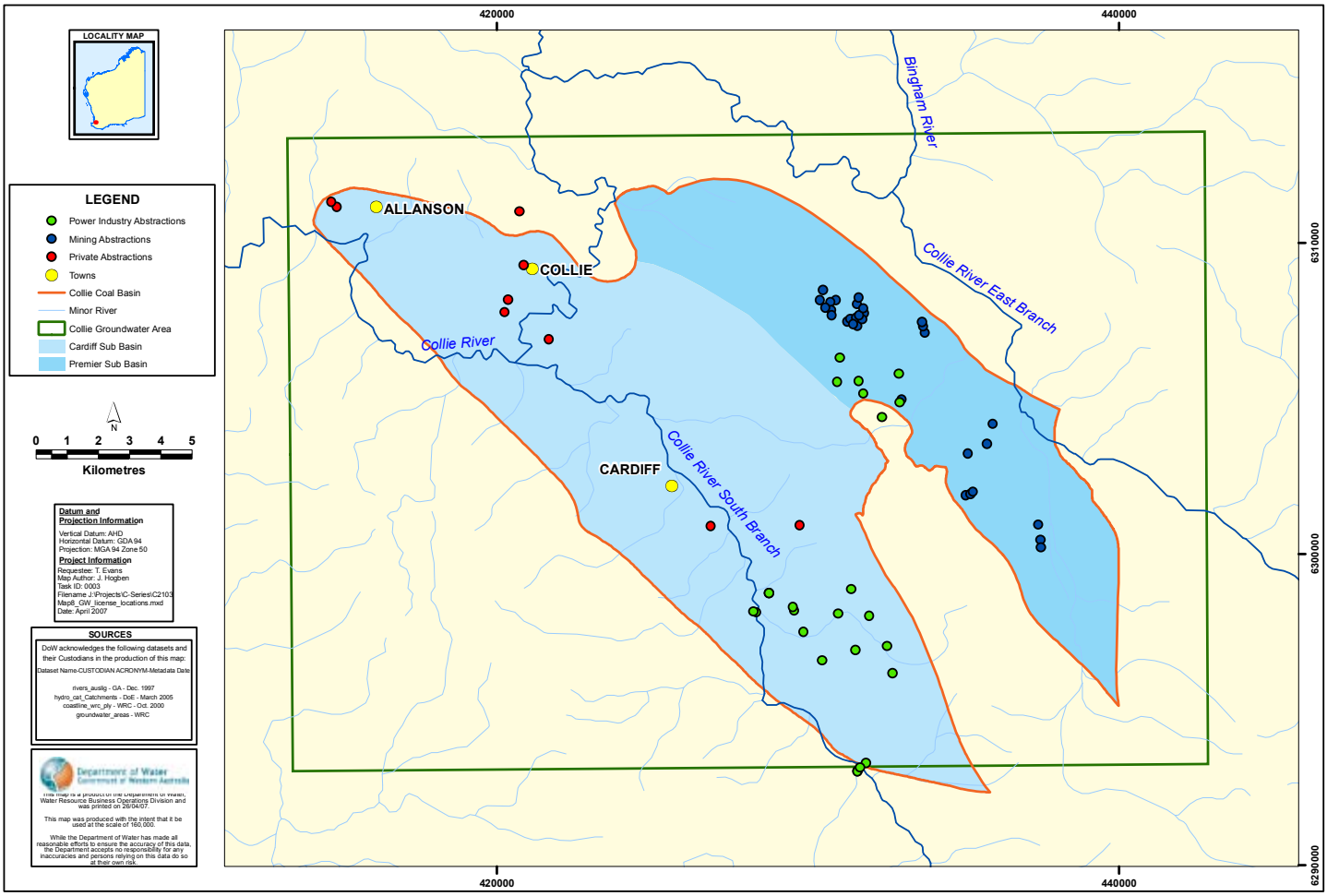


Figure 7. Licensed groundwater abstraction draw points within the Cardiff and Premier sub-areas

Collie Power Station

What is the sustainable yield of the Collie Coal Basin?

The ecologically sustainable yield of a system is the amount that can be abstracted over time from a resource while meeting the needs of the ecology.

During dewatering practices, aquifers are abstracted beyond what is considered to be the ecologically sustainable yield of the system. This is to allow for safe mining practice below the water table.

In the Premier sub-area, dewatering is important given the economic and social significance of coal mining to the region and the state. The Premier sub-basin is abstracted to the level considered appropriate for safe mining. This is beyond the ecologically sustainable yield.

In the Cardiff sub-area, where mining no longer occurs, the amount of available water is being assessed as part of the Upper Collie water management plan.

Coal mining and mine dewater use

Underground and open cut coal mining has taken place in the Collie Coal Basin since 1898. Groundwater in the Collie Coal Basin has been heavily dewatered for coal mining and groundwater tables have been significantly altered.

Dewatering groundwater is an important part of safe mining practice below the groundwater table. This means that the Department of Water issues licences for groundwater dewatering, based on the amount and timing of groundwater abstraction required for safe mining purposes.

Currently there are three licences to dewater up to 49 gigalitres of water each year from the Premier sub-basin; however, this maximum volume is generally not abstracted each year. Most of the groundwater from mine dewatering is diverted to power stations for use as cooling water in power generation. A small amount is used in mining operations for dust control and machine wash down.

Excess mine dewater that is not required for power generation, or not suitable quality for power generation, is released to the Collie River South Branch via Stockton Lake.

The Department of Water recognises that there are problems associated with this dewater release. This includes the loss of a high quality water resource, inundation of the receiving water body and the flooding of private property when Stockton Lake overflows during some winter months. The Department is working with Griffin Coal Mining Company to prepare a dewater disposal strategy that addresses these issues.

Open cut coal mine in the Collie Basin

Up until 1995, all mining was predominately in the Cardiff sub-basin. Mining in Cardiff sub-basin ceased in 1997 and since then mining has taken place in the Premier sub-basin at the Muja, Ewington and Premier mine sites.

Currently, Griffin Coal Mining Company (Griffin) and Wesfarmers Premier Coal Pty Ltd (Wesfarmers) are the two companies which have licences to dewater groundwater in the Collie Coal Basin.

What does drawdown of groundwater mean for the environment?

The overdraw of groundwater results in a drop in the overall water table. This leads to environmental stress in areas that are dependent on groundwater. In the Collie Coal Basin, ecosystems such as the groundwater-dependent river pools have been impacted by groundwater drawdown.

The Department of Water works with the local coal mining companies and the power station industry to ensure that mitigation strategies are in place where the environment has or will suffer as a result of groundwater use. Companies whose water use has an impact on the local environment, are required to assess where they may have an impact and monitor the impacts over time, until the system recovers and the values are restored.

Water demand for power stations

Verve Energy (formally Western Power Corporation) currently owns two coal-fired power stations within the basin – Muja and Collie 'A'. Together these stations supply around two-thirds of the electricity in the South West Interconnected System (SWIS).

Secure water supply is essential for the power generation process, as power stations require water to operate boilers and cooling towers.

When Muja was first opened in 1966, the power station's water was sourced from the Wellington Reservoir. However, due to deteriorated water quality, this source was abandoned and large amounts of groundwater were abstracted as an alternative.

In the 1990s due to significant groundwater declines, it became a priority to limit groundwater abstraction as much as was practical. To do this, Verve Energy uses a combination of mine dewater, groundwater and recycled water. Note that Verve Energy recycles water up to four times, with around 25 per cent of its water demand met through recycled water.

Power generation relies on a 100 per cent security of water supply, including availability for daily peak summer demands when electricity demand is at its highest. Mine dewater can be unreliable as a source for power supply because it is difficult to forecast exactly how much dewater will be available at any one time.

Groundwater investigations and resource performance

In the late 1990s, the Department of Water installed 90 monitoring bores (CRM series) throughout the basin. Following this work, the Department developed a three-dimensional groundwater flow model with information from the bores.

This work enhanced our understanding of the groundwater systems, including how they have been affected by heavy coal mine dewatering and abstraction for power station water supply.

The Department of Water's groundwater investigations also allowed for refined management boundaries and groundwater resource planning. The basin is now divided into Premier and Cardiff sub-basins, based on the hydro-geology of the basin.

There is an extensive monitoring network across the basin totalling 129 bores, plus additional bores drilled and monitored by the mining and power industry (Figure 8).

Each year, groundwater bore monitoring data is provided to the Department of Water by the major groundwater users – Griffin Coal Mining Company, Wesfarmers Premier Coal and Verve Energy. These companies also supply monthly abstraction data to the Department.

Muja power station in the Collie Basin (source: Verve Energy)

Groundwater monitoring (observation) bore

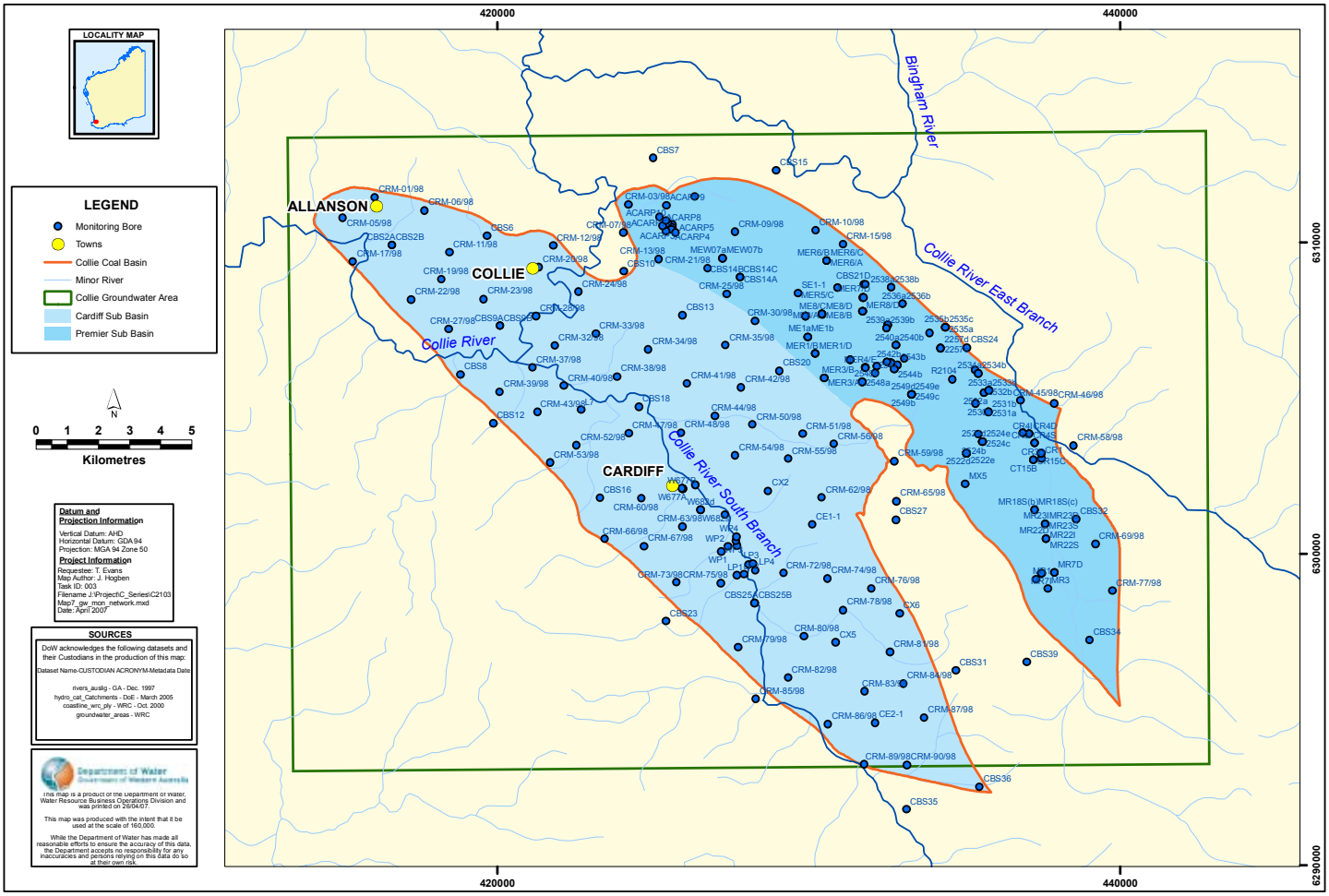


Figure 8. Groundwater monitoring network

Groundwater monitoring has shown that groundwater abstraction for mining and power generation has significantly reduced the watertable and modified the groundwater flow patterns in the basin. However, in the Cardiff sub-area, where mining has now ceased and power station use has been minimised, groundwater levels are recovering, in some parts by as much as two metres.

7 Water-dependent values

What is a water-dependent value?

Part of assessing how much water is available for licensing, is to identify where the environment relies on fresh, good quality water supply from the rivers, tributaries and groundwater table within the water management area.

Our environment includes the vegetation growing along the riverside, marron in the river bed, wetlands that depend on groundwater during the summer months, or a healthy river flow for canoeists. The Department of Water considers each of these components of the environment as a non-consumptive value. This is because although the environment requires water, it is not actually taking the resource out of the system.

The Department of Water has completed a number of studies to identify non-consumptive values that depend on water within the Upper Collie. Identifying these values and how much water they need to survive, allows us to manage and protect them by ensuring there is enough water left in the system to meet their requirements.

Ecological values

The Department of Water has commissioned a number of studies in the Upper Collie, to identify ecological features within the catchment and their water requirements (WEC & Streamtec, 2001 and Hardcastle et al, 2003). More recently, the Department of Water commissioned Wetland Research and Management (2007) to identify ecosystems dependent on flows from the Collie River east branch and Bingham River. The study assessed the maximum amount of water that could be diverted from the Collie River east branch while still maintaining ecological values downstream of the diversion site.

Water-dependent ecological values identified in the Upper Collie include freshwater crustaceans, long-necked tortoises, various frogs, fish, water rats, riparian vegetation, and aquatic macro-invertebrates.

Fresh water crayfish

Two Western Australian endemic freshwater crayfish have been identified – *Cherax quinque-carinatus* (gilgie) and *Cherax cainii* (marron).

Fish

A variety of fish exist within the Collie River. Wetland Research and Management (2007) identified four native species: the night fish (*Bostockia porosa*); the western minnow (*Galaxias occidentalis*); the western pygmy perch (*Edelia vittata*); and the freshwater cobbler (*Tandanus bostocki*). These represent over half of the seven endemic fresh water fish known to have previously existed in this area of the south west (although it is not known whether all of the endemic south-west fish existed in the Upper Collie).

Wetland Research and Management (2007) also identified two introduced species (mosquito fish, *Gambusia holbrooki* and redfin perch, *Perca fluviatilis*).

Gilgie, Cherax quinquecarinatus

Marron, *Cherax Cainii*

Nightfish, *Bostockia Porosa*

Western Pygmy Perch, *Edelia Vittata*

Catfish, *Tandanus Bostocki*

Western Minnow, *Galaxias Occidentalis*

Redfin Perch, *Perca Fluviatilis*

Table 6. Summary of native fish species known to occur in the Upper Collie River system

Scientific name	Common name	Location*	Study
Bostockia porosa	Nightfish	• Collie River (Collieburn Pool, Cox's Pool, Western Collieries, & Davies' Pool) • Lower Collie River (between Wellington Dam and Burekup Weir) • Lower Collie River (below Burekup Weir, downstream to Australind bypass)	• Morgan et al. 1998 • WRM 2003 • WRM 2003
Galaxias occidentalis	Western minnow	• Collie River (Collieburn Pool, Cox's Pool, Round Pool, Western Collieries, & Davies' Pool) • Lower Collie River (in a pool against the base of Burekup Weir)	• Morgan et al. 1998 • WRM 2003
Edelia vittata	Western pygmy perch	• Collie River (Cox's Pool, Round Pool, Western Collieries, & Davies' Pool) • Lower Collie River (below Burekup Weir, downstream to Australind bypass)	• Morgan et al. 1998 • WRM 2003
Tandanus bostocki	Cobbler	• Lower Collie River (below Burekup Weir, downstream to Australind bypass)	• WRM 2003

*Note some of the pool names have changed over time and may be different to those currently used.

Social and cultural values

A social water requirement is the amount of water that is needed to maintain social values, such as swimming in or picnicking by a permanent river pool.

A cultural water requirement is the amount of water that is needed to maintain an important cultural feature. Collie River is significant to the local Aboriginal custodians and much of the Collie and Harris rivers are registered Aboriginal heritage sites. A number of important cultural values exist in the Upper Collie; for example, the permanent groundwater-fed river pools where the Walgu (or Hairy Faced Snake) rests.

Social and cultural water requirements often have conditions for the quality of the water that is needed, as well as the volume. This means that water requirements in terms of suitable pH, salinity concentrate and heavy metal concentrates are considered.

The Department of Water recently contracted Beckwith Environmental Planning (2007) to identify water features in the Upper Collie important to local people, industry, government and community groups. Stakeholders were asked about which water-dependent features (that is locations or attractions) held value to them and what the water requirement would be to maintain that value.

If you would like more information or a copy of the issue scoping study please contact the Department of Water's Bunbury office or email: collieplanning@water.wa.gov.au

WEC & Streamtec, 2000 and WEC & Streamtec, 2001 also completed studies relating to water requirements for social values in the Upper Collie.

The water features and social values identified by Upper Collie stakeholders are summarised in Table 7.

Table 7. Summary of key water features and their social value

Feature	Aboriginal heritage/cultural	Non-Aboriginal heritage [1]	Aesthetic	Education	Research	Fire suppression	Water for stock	Tourism	Canoeing	Swimming	Water skiing	Fishing	Marroning	Picnicking	Camping
Wellington Reservoir	✓	✓	✓					✓	✓	✓		✓	✓	✓	✓
Collie River below Wellington Reservoir	✓		✓	✓				✓	✓	✓		✓		✓	✓
Lake Kepwari					✓			✓		✓	✓			✓	✓
Pools on the Collie River South Branch	✓	✓	✓			✓	✓		✓	✓					
Pools on the Collie River East Branch	✓	✓	✓			✓	✓			✓					
Stockton Lake					✓					✓	✓			✓	✓
Harris Reservoir	✓	✓											✓	✓	
Minninup Pool	✓	✓	✓						✓	✓				✓	
Black Diamond A					✓					✓					
Collie River (between Harris Dam and Minninup Pool)	✓		✓						✓	✓		✓		✓	

1 Natural and cultural heritage values are the qualities that make a specific place important to the community. Heritage values are often separated into natural, historic and Indigenous categories.

8

Managing the impacts of water use

How does the Department of Water achieve impact management?

To ensure water users best manage their impacts, the Department of Water develops conditions, as part of licences or operating strategies, in negotiation with the users and in line with regulations and policy.

The Upper Collie water management plan will outline licensing rules and policies to ensure that water users in Upper Collie are managing their impacts.

The Department of Water is responsible for regulating water use. This means that the Department has to ensure that water users monitor, manage and mitigate their impacts on the environment, and other water users, as much as possible.

Supplementing river pools

The Upper Collie River overlays the Collie Coal Basin. The two systems are highly interconnected with the groundwater of the Collie Coal Basin discharging into the river at various points. Over the low rainfall, summer months, the Collie River is likely to have stopped flowing. At no flow, the river would become a series of permanent, groundwater-fed river pools.

Since the inception of coal mining and power generation in the Collie Coal Basin, the river pool levels have dropped or dried out completely due to a decline in groundwater levels. It is understood that the decline is associated with abstraction and dewatering activities for power and mining activities.

Along the east and south branches of the Collie River there are a number of river pools that are considered locally to have social values, including swimming and canoeing.

The Collie Water Advisory Group (CWAG) devised a strategy for river pools to be supplemented with groundwater. Supplementing pools was intended to ease the impact of groundwater over-abstraction on the river pools and satisfy the local community's desire for permanent pools during the summer months.

Over the past 10 summers, between 1997 and 2007, Verve Energy has supplemented Long, Walkers, B. Cox, Cardiff, Grahams, Piavaninis and Chinamans pools, along the Collie River South branch. Since 2000, Verve Energy has used around 1.7 GL of groundwater each summer to supplement the pools.

Over the same time, Griffin Coal has supplemented the Duderling and Buckingham pools of the Collie River East Branch. Since 2000, Griffin Coal has used around 0.25 GL of groundwater to supplement pools each summer.

Figure 9. Supplemented river pools

Is the pool water quality being monitored?

Griffin Coal monitors the water quality of Duderling pool on the Collie River East Branch on a monthly basis for pH and salinity. The results are reported in the Griffin annual rehabilitation and environmental program report.

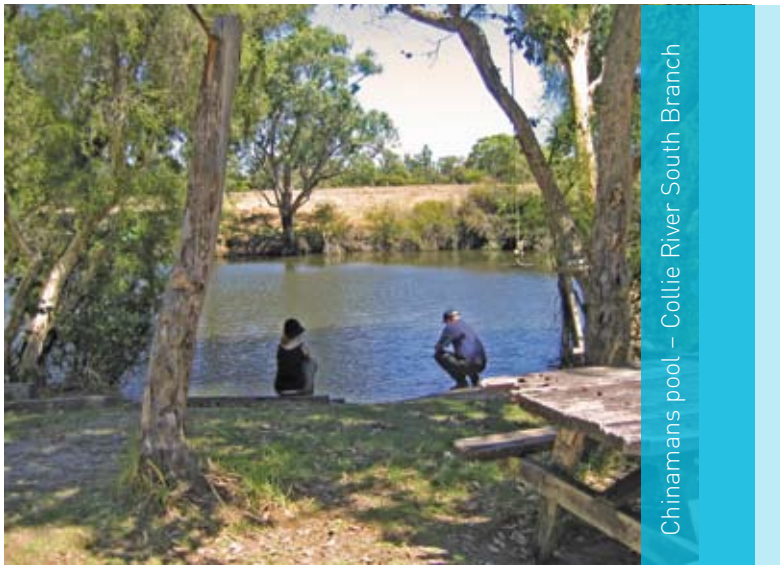
No regular monitoring of the water quality of the Collie River South Branch pools has been done since supplementation began. However, Verve Energy has monitored the water quality of the bore water used in river supplementation.

The monitoring programs are currently under review.

Reviewing the Collie River pool supplementation scheme

In October 2006, the Department of Water began to review the pool supplementation practices of the previous 10 years. The Department of Water convened a review group made up of representatives from the Department of Water, Department of Environment and Conservation, Verve Energy, Griffin Coal Mining Company and Wesfarmers Premier Coal.

The review group has assessed: how well the supplementation scheme has met its initial objectives; how the supplementation has taken place (including timing, volume and water quality); and how supplementation should be run in the future.



Chinamans pool – Collie River South Branch

As part of assessing the pool supplementation, the Department of Water reviewed the groundwater levels surrounding the seven pools of the South Branch. The Department reviewed the levels to establish how much groundwater had recovered in the area and if pool supplementation was still required to maintain pool water levels.

Cardiff Pool: Over the past six years, the groundwater level in this area has recovered by approximately two metres. The groundwater level is now high enough for a small volume of groundwater to discharge into the pool over summer.

Chinamans Pool: Over the past six years, groundwater levels have remained stable in the vicinity of this pool. Groundwater and dewater (from the Ewington mine, in the Premier sub Basin) discharges into the pool. This maintains the pool at a depth of 5.2 metres and supports social values of picnicking, swimming and marroning. Since groundwater levels are stable in the pool vicinity the pool does not require supplementation.

As part of the review, in February 2007, the Department of Water inspected Verve Energy's water discharge site for river pool supplementation on the South Branch. The discharge of supplementation water (from both WD6 and WD2 bores) into the river resulted in a massive build-up of rust-brown sludge in the river bed.

The Department of Water deemed this sludge to pose a direct threat to the health of the river. The Department requested Verve Energy to clean-up the site and cease supplementing the pools until alternative safe water sources were found.

In August 2007, as part of the review, the Department of Water held information sessions on pool supplementation for the local Collie community. Part of the information sessions involved surveying the community on how they valued the pools.

If you would like more information on the workshops or the survey please contact the Department's Bunbury office or

email: collieplanning@water.wa.gov.au

Glossary

Abstraction	The permanent or temporary withdrawal of water from any source of supply, so that it is no longer part of the resources of the locality.
Aboriginal heritage	Includes both the physical and cultural aspects and relates to the significance of places and objects to Aboriginal people in terms of traditions, observations, customs and beliefs.
Allocation limit	The estimated maximum volume of water (including Public Water Supply Reserves and approved reserves) that is permitted to be abstracted during a year from a water resource, which considers the impacts on dependent economic, social and ecological values.
Aquifer	A geological formation or group of formations capable of receiving, storing and transmitting significant quantities of water. Usually described by whether they consist of sedimentary deposits (sand and gravel) or fractured rock. Aquifer types include unconfined, confined, and artesian.
Dissolved oxygen	The concentration of oxygen dissolved in water or effluent, normally measured in milligrams per litre (mg/L).
Ecological values	A measure of the significance or interest of an area as a habitat supporting species of flora and fauna.
Ecological water requirements	The water regime needed to maintain ecological values of water-dependent ecosystems at a low level of risk.
Ecosystem	A community or assemblage of communities of organisms, interacting with one another, and the specific environment in which they live and with which they also interact, eg lake, to include all the biological, chemical and physical resources and the interrelationships and dependencies that occur between those resources.
Environment	Living things, their physical, biological and social surroundings, and interactions between all of these.
Environmental water provisions	The water regimes that are provided as a result of the water allocation decision-making process taking into account ecological, social and economic values. 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.

Gigalitre (GL)	A measure equal to 1 million kilolitres (kL) or 1 billion litres.
Groundwater	Water which occupies the pores and crevices of rock or soil beneath the land surface.
Groundwater area	An area proclaimed under the *Rights in Water and Irrigation Act 1914* in which private groundwater abstraction is licensed.
Integrated Water Supply Scheme (IWSS)	The Perth integrated water supply scheme is supplied from multiple groundwater and surface water (dam) water sources and the Perth seawater desalinisation plant and services the area from Quinns Rocks to Mandurah and incorporates the Goldfields and agricultural water supply.
Kilolitre (kL)	A term commonly used to measure water, equal to 1,000 litres. A cubic metre is the volume occupied by a cube measuring one metre along each edge. One cubic metre contains one kilolitre of water which weighs approximately one tonne.
Licence	A formal permit which entitles the licence holder to 'take' water from a watercourse, wetland or underground source.
Megalitre (ML)	Unit of (water) volume; one million litres, a thousand kilolitres or a thousand cubic metres.
Salinity	The measure of total soluble salt or mineral constituents in water. Water resources are classified based on salinity in terms of Total Dissolved Salts (TDS) or Total Soluble Salts (TSS). Measurements are usually in milligrams per litre (mg/L) or parts per thousand (ppt).
Social water requirements	Elements of the water regime that are identified to meet social (including cultural) values.
Surface water	Water flowing or held in streams, rivers and other wetlands on the surface of the landscape.
Watertable	The saturated level of the unconfined groundwater. Wetlands in low-lying areas are often seasonal or permanent surface expressions of the watertable.

References

Beckwith Environmental Planning. 2007. *Upper Collie issue scoping report.* Prepared for the Department of Water.

Collie Water Advisory Group (CWAG) 1996, *Strategies for Water Resource Management in the Collie Basin.* Co-ordinated by the Department of Resources Development.

Collie Water Advisory Group (CWAG) 1999, *Collie Basin Water Resource Management – Reconsideration of Long and Short Term Strategies.* Co-ordinated by the Department of Resources Development.

Hardcastle K., Rose T., Pearcey M.R. and Storey A. 2003, *Synthesis Report – Lower Collie River Ecological Water Requirements Review: Stream Morphology, Riparian Vegetation and Fish Passage,* Water and Rivers Commission.

Mauger, G., Bari M., Boniecka L., Dixon R.N.M., Dogramaci S.S. and Platt J. 2001, *Salinity Situation Statement: Collie River,* Water and Rivers Commission, Water Resources Technical Series No. WRT 29

Morgan DL, Gill HS & Potter IC, 1998. *Distribution, identification and biology of freshwater fishes in south-western Australia.* Records of the Western Australian Museum. Supplement No. 56. Western Australian Museum, Perth.

Varma. S. 2002, *Hydrogeology and Groundwater Resources of the Collie basin, Western Australia, Water and Rivers Commission,* Hydrogeological Record Series Report HG 5.

Water Corporation, 2003. Wellington, Harris and Mungalup Reservoirs (include transfers to IWSS) Water resource Management operation Strategy. Unpublished report to the Water and Rivers Commission.

Welker Environmental Consultancy and Streamtec Pty Ltd. 2001, *Environmental Water Provisions South Branch of the Collie River Downstream from Western 5 Open Cut.* Prepared for Water and Rivers Commission.

Welker Environmental Consultancy and Streamtec Pty Ltd. 2000, *Environmental Water Requirement Study – Harris River and East branch of the Collie River (downstream of the confluence) to the South branch.* Prepared for Water Corporation.

Wetland Research and Management, 2007. Collie river East branch, Preliminary ecological water requirements of the Collie River East Branch: Risk assessment of Slainity Mitigation Diversion Scenarios. Draft Report in review.

Wetland Research and Management, 2003. Wellington Below – EWR Review: Fish community including migration requirements. Unpublished report to the Water and Rivers Commission by Wetland Research and Management. March 2003.

Zhang, Q., Varma, S., Bradely, J., Schaeffer, J., (2007) *Groundwater Model of the Collie Basin, WA,* Hydrogeological Record Series No HG 12. Department of Water, Perth

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