



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

*Looking after all our water needs*



Mungalup Dam Catchment Area  
drinking water source protection plan  
Collie South and Mungalup town water supply



# Mungalup Dam Catchment Area drinking water source protection plan

Collie South and Mungalup town water supply

Looking after all our water needs

Department of Water

Water resource protection series

Report WRPS 103

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**Department of Water**

168 St Georges Terrace

Perth WA 6000

Telephone +61 8 6364 7600

Facsimile +61 8 6364 7601

[www.water.wa.gov.au](http://www.water.wa.gov.au)

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All maps in this publication were produced by the Department of Water (for the Water Resource Management Division) with the intent that they be used for the *Mungalup Dam Catchment Area* at the scale shown on the maps.

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

For more information about this report, contact the Department of Water (Water Source Protection Branch) on +61 8 6364 7600 or send your enquiry to <[drinkingwater@water.wa.gov.au](mailto:drinkingwater@water.wa.gov.au)>.

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# Preface

The Department of Water has prepared this drinking water source protection plan to assess risks to water quality within the Mungalup Dam Catchment Area and to recommend management strategies to avoid, minimise or manage those risks. The department is committed to protecting drinking water sources to meet public health requirements and ensure the supply of a reliable, safe, good quality drinking water to consumers.

The *National water quality management strategy: Australian drinking water guidelines 6, 2004* (NHMRC & NRMCC 2004a) recommends a risk-based, multiple-barrier approach to protect public drinking water sources. Catchment protection is the first barrier against contamination, with subsequent barriers implemented at the water storage, treatment and distribution stages of a water supply system. Catchment protection requires an understanding of the catchment and hazards that can compromise drinking water quality. It then requires the development of preventative strategies and operational controls to ensure the safest possible water is supplied to consumers.

This protection plan details the location and boundary of the drinking water source, which provides water to the Collie South and Mungalup town water supply. It discusses existing and future use of the water source, describes the water supply system, identifies risks and recommends management approaches to address these risks and protect water quality.

This plan has been prepared to guide state and local government agency land-use planning and development decisions. The Department of Environment and Conservation has a significant role in this catchment as it is located on crown land and managed as a state forest/timber reserve. Stakeholders should use this document as a guide for protecting the quality of water in the proposed Mungalup Dam Catchment Area.

The stages involved in the preparation of this drinking water source protection plan were:

Stages in development of a plan		Comment
1	Prepare drinking water source protection assessment document.  (July 2004)	Prepared after initial catchment survey and preliminary information gathering. This document may not be required if a drinking water source protection plan already exists or alternative documents provide suitable information.
2	Conduct stakeholder consultation.  (December 2007)	Advice sought from key stakeholders using the assessment document as a tool for information and discussion.
3	Prepare draft drinking water source protection plan.  (March 2008)	Draft protection plan developed taking into account input from stakeholders and any additional advice.
4	Release draft drinking water source protection plan.  (April 2009)	Draft protection plan released for a six-week public consultation period.
5	<b>Publish approved drinking water source protection plan.</b> <b>(June 2009)</b>	<b>Final protection plan published after considering submissions. Includes recommendations on how to protect water quality. Proclamation of public drinking water source area can now occur.</b>



## Summary

Mungalup Dam is on Mungalup Brook, a tributary of the Collie River in the south-west of Western Australia. It is located approximately six kilometres south-west of the Collie townsite.

All the land within the catchment is under Crown ownership and is managed by the Department of Environment and Conservation as a state forest/timber reserve.

In the past, the reservoir and its bank have been used for unauthorised activities such as swimming, marroning and camping. These activities involve people and their pets in contact with the water body or in proximity to the water. Such activities are not appropriate, nor are they consistent with the Conservation and Land Management Regulations 2002 or the Country Areas Water Supply Act By-laws 1957, due to the risk of contamination to the drinking water source. These activities need to be directed to other designated areas in order to provide for a safe drinking water source, now and in the future. Ongoing education and monitoring will be required to manage these issues.

In addition to safe, good quality drinking water, recreation sites and facilities are also important to public health. In the Collie region there are multiple alternative sites available or proposed for a range of recreational purposes, including swimming – such as Minnipup Pool, Stockton Lake, Lake Kepwari, Glen Mervyn Dam, Honeymoon Pool and Lennard Drive.

It should be noted that existing legislation and policy that prevents some recreational activity in drinking water reservoirs/dams is planned to be reviewed by government to determine if it is still appropriate for WA. Should that review lead to change in the current legislation and policy, this protection plan will be changed accordingly.

The management objective for the Mungalup Dam Catchment Area is to preserve and protect the high quality of raw water used for public drinking water supply, by avoiding the risk of contamination from inappropriate land uses and activities.

The following water quality protection strategies are recommended:

- the Mungalup Dam Catchment Area should be proclaimed under the *Country Areas Water Supply Act 1947*
- the Water Corporation, the Department of Environment and Conservation and the Department of Water need to continue cooperation in the management of this catchment, as well as coordinate assessments and approvals for land uses in this catchment
- best management practices for approved existing and future land uses and activities within the catchment area should be implemented.

This plan has been prepared in consultation with key stakeholders, including the Water Corporation, the Department of Environment and Conservation, the Conservation Commission of Western Australia and the Shire of Collie.

# 1 Drinking water source overview

Mungalup Dam is located on Mungalup Brook, a tributary of the Collie River in the south-west of Western Australia, approximately 200 kilometres (km) south of Perth and six km south-west of the Collie townsite (see Figure 1). The small rural community of Mungalup is located approximately 500 metres (m) downstream of the dam. The dam is used by the Water Corporation to supply public drinking water to the southern part of Collie (south of Throssell Street) as well as Mungalup.

Collie is a large regional centre, servicing local mining, power generation and timber industries. It has a population of 7084 (Australian Bureau of Statistics 2006).

Mungalup Dam Catchment Area has an area of 6.2 square kilometres (km<sup>2</sup>) and is located within the Shire of Collie. The reservoir and catchment are shown in Figure 2 and Figure B1 (see Appendix C).

## 1.1 Existing water supply system

Mungalup Dam is a 13 m high earth structure constructed in 1935. The reservoir covers an area of 16.2 hectares (ha) and has a storage capacity of 692 megalitres (ML).

The reservoir was the original source of water for the town of Collie until the northern part of the townsite was connected to the Great Southern Town Water Supply Scheme (GSTWSS) in the early 1950s. It now supplies the area south of Throssell Street in Collie and the Mungalup townsite. Water is gravity-fed from the reservoir into the reticulation system.

## 1.2 Water treatment

Raw water from Mungalup Dam is dosed with fluoride and chlorinated prior to supply as drinking water. Chlorination provides a disinfection barrier against possible microbiological contamination.

It should be recognised that although treatment and disinfection are essential barriers against contamination, catchment management is the first step in protecting water quality and ensuring a safe, quality drinking water supply. This approach is endorsed by the *National water quality management strategy: Australian drinking water guidelines 6, 2004 (ADWG)* (NHMRC & NRMCC 2004a) and reflects a risk-based, multiple-barrier approach, for providing safe drinking water to consumers. This combination of catchment protection and water treatment will deliver more reliable, safe, lower cost drinking water to consumers than either approach could achieve individually.

## 1.3 Catchment details

### 1.3.1 Physiography

Mungalup Dam Catchment Area lies within the Darling Plateau which consists of an undulating, dissected peneplain with gravelly, pale orange soils cloaked by extensive areas of tall forest. Deep, steep-sided valleys occur throughout the area, occasionally punctuated by dome-shaped granite outcrops.

The area is characterised by open forests of jarrah, marri, sheoak and blackbutt.

### 1.3.2 Climate

The area has a temperate climate, characterised by warm, dry summers and cool, wet winters. The average rainfall for Collie (based on data from 1971–2000) is 850.1 millimetres (Bureau of Meteorology 2007).

### 1.3.3 Hydrology

Mungalup Dam catchment has an elevation of 251.5 m Australian Height Datum (AHD) at the reservoir rising to 334 m AHD at the head of the catchment. The estimated annual average stream flow to the reservoir is 550 megalitres (ML) with an average yield of 250 megalitres per year (Water and Rivers Commission 1996).

## 1.4 Future water supply requirements

The GSTWSS is available to supplement supply to south Collie and Mungalup if Mungalup Dam is not able to meet all future drinking water demands.

## 1.5 Existing drinking water source protection

Mungalup Dam is located within the Wellington Dam Catchment Area which was proclaimed in 1957 under the *Country Areas Water Supply Act 1947*.

The Wellington Dam Catchment Area boundary was amended on 14 November 2000 under the *Country Areas Water Supply Act 1947* for the purpose of public drinking water source protection. By-laws created under this Act enable the Department of Water to control potentially polluting activities, to regulate land use, inspect premises and take the necessary steps to prevent or clean up pollution.

Mungalup Dam Catchment Area has not specifically been proclaimed under the *Country Areas Water Supply Act 1947* as it is protected by the Wellington Dam Catchment Area proclamation. However, one of the recommendations of this plan is to proclaim the Mungalup Dam Catchment Area separately.

The Department of Water has delegated powers of monitoring and by-law enforcement to the Water Corporation for some public drinking water source areas

(PDWSAs). Please refer to section 4.7 *Surveillance and by-law enforcement* for more information.

In 2004, the Water Corporation prepared the *Mungalup Dam Catchment Area drinking water source protection assessment*. This document outlined risks to water quality from land uses and activities in the Mungalup Dam Catchment Area. This drinking water source protection plan updates and replaces the drinking water source protection assessment.

Water quality protection matters are also provided by Department of Environment and Conservation under the Conservation and Land Management Regulations 2002. The Department of Water, Water Corporation and Department of Environment and Conservation need to continue to liaise on source protection issues in this catchment.

## 1.6 Department of Water management

### 1.6.1 Current allocation licence

Water resource use and conservation in Western Australia is administered by the Department of Water in accordance with the *Rights in Water and Irrigation Act 1914*. Under the Act, the right to use and control surface and groundwater is vested with the Crown. This Act requires licensing of surface water abstraction (removing water from a waterway) within proclaimed surface water areas.

The Water Corporation is licensed to draw 500 ML/year from Mungalup Dam for public water supply to Collie and Mungalup. Abstraction in 2007–08 was 212.694 ML.

### 1.6.2 South West regional water plan

Mungalup Dam Catchment Area is within the South West region of Western Australia. The *South West regional water plan – strategic directions* was released recently by the Department of Water for public comment. This plan provides a strategic overview of the major challenges facing the South West region due to regional growth and climate change. A main objective in the plan is that protection of all drinking water sources is ensured (Department of Water 2008). Copies can be obtained from <[www.water.wa.gov.au](http://www.water.wa.gov.au)> select Publications > Find a publication. Alternatively you can contact the Program Manager, Regional water planning (Perth office) on (08) 6364 6833.

### 1.6.3 Upper Collie water management plan

In Collie, water is proposed to be licensed and allocated for use as per the *Upper Collie water allocation plan* (released in 2008). For a copy of this plan visit <[www.water.wa.gov.au](http://www.water.wa.gov.au)> select Publications > Find a publication > A-Z Browse > U > Upper Collie surface and groundwater. Alternatively, you can contact the Program Manager of Allocation Planning, South West region office on (08) 9726 4111.

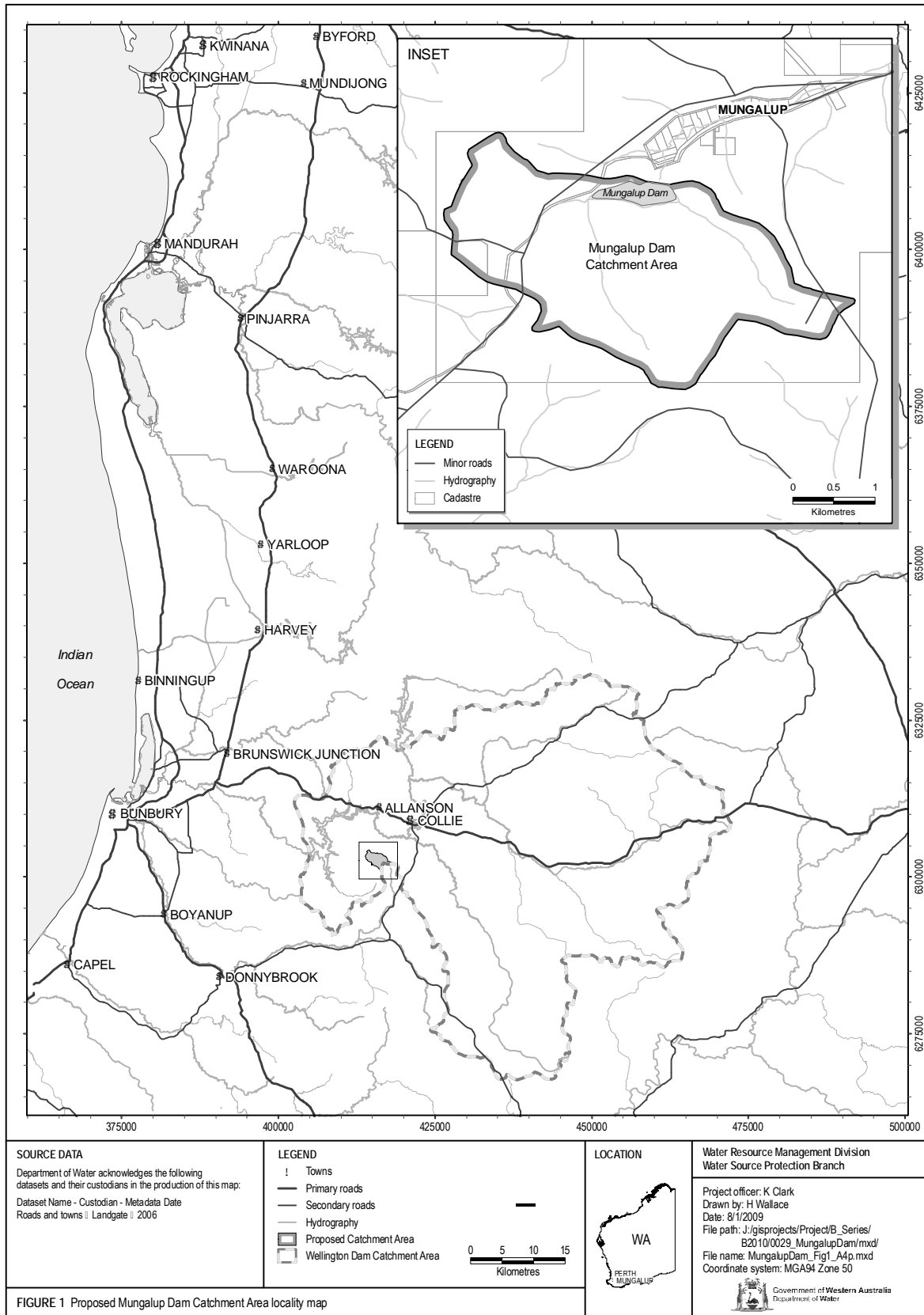


Figure 1 Proposed Mungalup Dam Catchment Area locality map

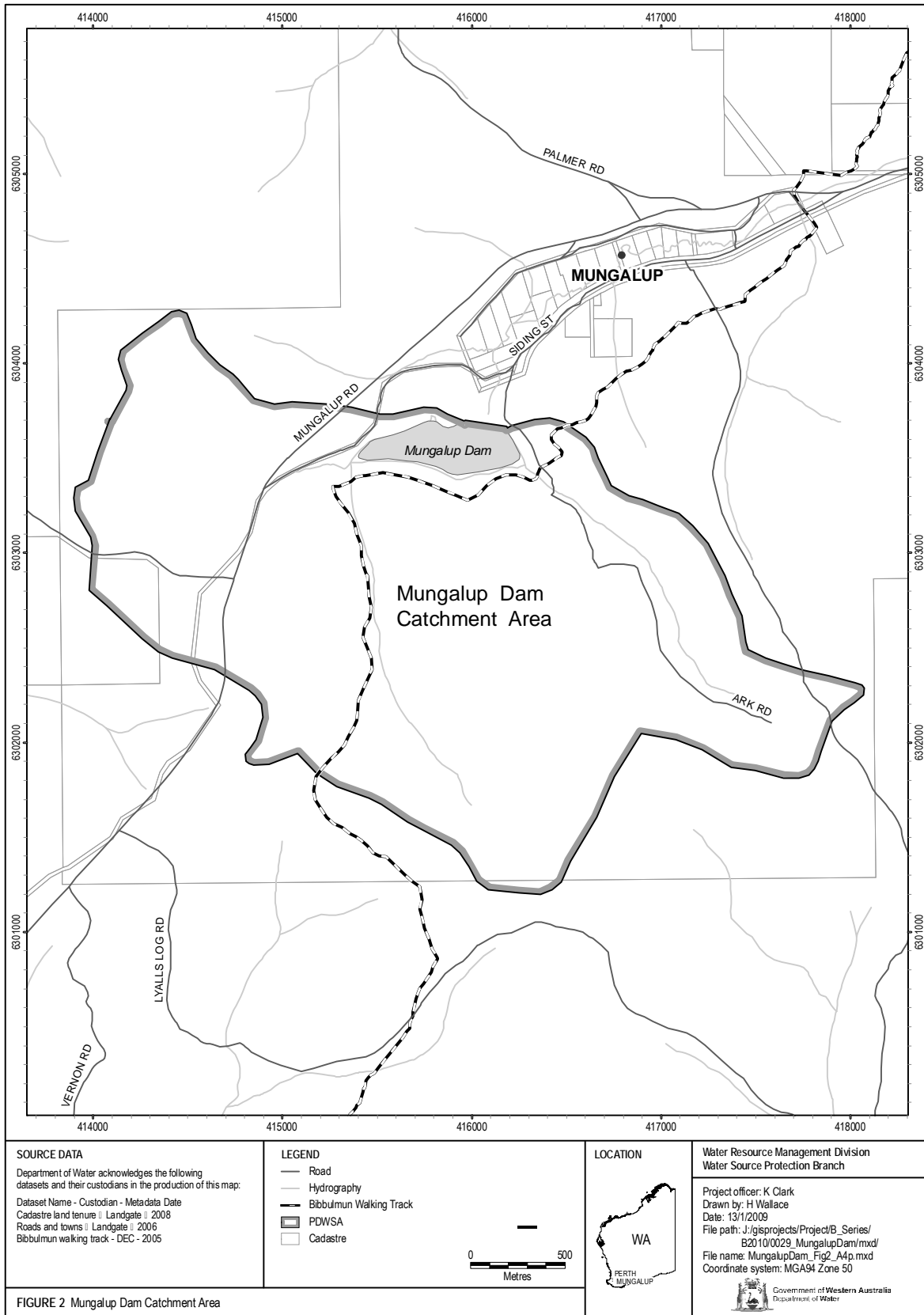


Figure 2 Mungalup Dam Catchment Area

## 2 Water quality monitoring and contamination risks

A wide range of chemical, physical and microbiological factors can impact on water quality and therefore affect the provision of safe, good quality drinking water to consumers.

The Water Corporation regularly monitors the quality of raw water from the Mungalup Dam for microbiological, health-related and aesthetic (non-health-related) characteristics. This data shows the quality of water in the reservoir. An assessment of the drinking water quality provided to the consumer is also made against the ADWG to ensure safe, good quality drinking water is available to consumers. This assessment is made by an intergovernmental committee called the Advisory Committee for the Purity of Water that is chaired by the Department of Health.

A water quality summary for the Mungalup Dam from September 2003 to August 2008 is presented in Appendix A. For more information on water quality, see the Water Corporation's most recent drinking water quality annual report at <[www.watercorporation.com.au](http://www.watercorporation.com.au)> Publications > Water quality > Water quality annual report.

Contamination risks relevant to the Mungalup Dam Catchment Area are described below.

### 2.1 Microbiological

Pathogens are types of micro-organisms that are capable of causing diseases. These include bacteria, protozoa and viruses. In water supplies, pathogens that can cause illness are mostly found in the faeces of humans and domestic animals (such as dogs and cattle).

There are a number of pathogens that are commonly known to contaminate water supplies worldwide. These include bacteria (e.g. salmonella, *Escherichia coli* and cholera), protozoa (for example, *Cryptosporidium*, *Giardia*) and viruses. *Escherichia coli* counts are a way of measuring these pathogens and are an indicator of faecal contamination.

Pathogen contamination of a drinking water source is influenced by many factors such as the existence of pathogen carriers (e.g. humans and domestic animals), the transfer to and movement of the pathogen in the water source and its ability to survive in the water. The percentage of humans in the world that carry pathogens varies. For example, it is estimated that between 0.6 to 4.3 per cent of people are infected with *Cryptosporidium* worldwide, and 7.4 per cent with *Giardia* (Geldreich 1996).



When people (while fishing, marroning, swimming or the like) or domestic animals come into contact with a body of water, pathogens may enter that water source. This primarily occurs through the direct transfer of faecal material (even a very small amount can cause contamination) or indirectly through runoff moving faecal material into the water.

The ability of pathogens to survive in surface water also differs between species. Salmonella may be viable for two to three months, *Giardia* may still infect after one month in the natural environment (Geldreich 1996) and *Cryptosporidium* oocysts (cells containing reproductive spores) may survive weeks to months in freshwater (NHMRC & NRMCC 2004a).

The effect on people consuming drinking water that is contaminated with pathogens varies considerably, ranging from mild illness (such as stomach upset or diarrhoea) to death. In 2000 in Walkerton, Canada, seven people died due to contamination of the town water source and supply by a pathogenic strain of *Escherichia coli* and campylobacter (NHMRC & NRMCC 2004b). Commissioner O'Conner, who chaired the inquiry into the incident was very clear that the lack of any source protection was a major contributing factor (O'Conner 2002a,b).

## 2.2 Health related

Land and water-based uses and activities within a catchment can impact directly on water quality and treatment. For example, off-road driving contributes to erosion and the uprooting of vegetation, which can increase turbidity in water. The effectiveness of treatment processes, particularly chlorine disinfection, can be reduced by increased turbidity.

Erosion results in the mobilisation of soil particles that are released into the air and tributaries, increasing the turbidity of the main water body. Pathogens can adsorb onto these soil particles and may be shielded from the effects of disinfection. Increased turbidity also impacts upon other environmental constituents, i.e. smothering riparian vegetation and reducing the transfer of light within the water column, which affects plant growth.

Chemicals attached to suspended material, such as soil particles, can occur in drinking water sources. For example, this could occur as a result of natural leaching from mineral deposits or from different land uses (NHMRC & NRMCC 2004a). A number of these chemicals (organic and inorganic) are potentially toxic to humans.

Pesticides include agricultural chemicals such as insecticides, herbicides, nematicides (used to control worms), rodenticides and miticides (used to control mites). Contamination of a drinking water source by pesticides (and other chemicals) may occur as a result of accidental spills and/or incorrect use, overuse or leakage from storage areas. In such cases, prompt notification of relevant authorities and clean up is required.

Drinking water supplies can also be contaminated by nutrients such as nitrates from fertiliser application, faulty septic systems, leach drains and from domestic animal faecal matter that washes through or over soil and into a water source. Nitrate and nitrite can be toxic to humans at high levels, with infants younger than three months being most susceptible (NHMRC & NRMMC 2004a).

Hydrocarbons (e.g. fuels; oils) are potentially toxic to humans, and potentially harmful chemical by-products may be formed when they are combined with chlorine in the water-treatment processes. Hydrocarbons can occur in water supplies as a result of spills and leakage from vehicles.

## 2.3 Aesthetic

Impurities in drinking water can affect the aesthetic qualities of water such as its appearance, taste, smell and feel. Such impurities are not necessarily hazardous to human health; for example, water that is cloudy and has a distinctive odour or has a strong taste is not necessarily harmful to health, while clear, pleasant-tasting water may still contain harmful micro-organisms (NHMRC & NRMMC 2004b).

Iron and dissolved organic matter can affect the colour and appearance of water, and salinity can affect the taste. Some properties such as pH (a measure of acidity or alkalinity) can contribute to the corrosion and encrustation of pipes.

The ADWG sets aesthetic water quality criteria to meet the aesthetic requirements of consumers and to protect water supply infrastructure (such as pipes).

## 3 Land-use assessment

### 3.1 Existing land uses and activities

The Mungalup Dam Catchment Area is located over state forest. Current land uses and activities are outlined below. This information has been summarised in Table 1 at the end of this section. This table also identifies a recommended management priority for different hazards. Appendix B of this plan uses data in this section and Table 1 to recommend protection strategies for consideration by relevant stakeholders.

#### 3.1.1 State forest

The Mungalup Dam Catchment Area is located in state forest which is vested in the Conservation Commission of Western Australia and managed by the Department of Environment and Conservation (DEC) under the *Conservation and Land Management Act 1984*. DEC is obligated under the Act to prepare its management plans in consultation with the Department of Water and the Water Corporation and submit them to the Minister for Water Resources.

DEC manages the state's indigenous forest and timber reserves according to the *Forest management plan 2004–2013* (FMP). The purpose of state forest and timber reserves as outlined in the FMP includes conservation, recreation, timber production (on a sustainable yield basis), water catchment protection, and other purposes prescribed by the Conservation and Land Management Regulations 2002 (e.g. beekeeping).

Current land uses and activities undertaken in DEC-managed land in the Mungalup Dam Catchment Area are outlined below.

##### *Feral animal control*

The Mungalup Dam Catchment Area is baited with 1080 poison for fox control by DEC. 1080 poison is a naturally occurring chemical and breaks down quickly. The Department of Water is currently reviewing the use of 1080 in public drinking water source areas. For more information on the use of pesticides near drinking water source areas please refer to Statewide Policy No.2: *Pesticide use in public drinking water source areas* (Water and Rivers Commission 2000).

##### *Fire management*

Prescribed burning is carried out by DEC for biodiversity conservation and life and community asset protection such as townsites. Burning is carried out mainly from March through to May. Burning of this area is reviewed on a five- to seven-year rotation. Every second or third rotation, an autumn burn in April or May would also be prescribed.

One of the major risks to water quality from prescribed burning is turbidity. Turbidity is the presence of suspended solids such as soil and organic matter in water. These particles can aid the transport of some contaminants and mask the presence of others (e.g. pathogens). The main sources of suspended solids are soil erosion and disturbance of the stream bed.

Undertaking good management practices during prescribed burning (such as maintaining vegetation buffers along watercourses) can reduce turbidity levels.

#### *Roads and tracks*

There are tracks around the reservoir allowing full access to the water body. Some of these tracks are used by DEC for state forest maintenance and by the Water Corporation for water facility maintenance. Vehicle tracks seen below the high water mark shows that the public has access to the reservoir.

Mungalup Road is a sealed public road that passes through the catchment. It is used on a regular basis. Mungalup Tower Road is a strategic fire access road that is unsealed. Ark Road is also an unsealed road which allows public access right up to the water body.

Management measures to address unnecessary use of the unsealed roads (e.g. signage or gates) should be considered to prevent unauthorised public access around the reservoir.

#### *Timber production*

There are no pine plantations in the Mungalup Dam Catchment Area, although timber harvesting has occurred previously in the catchment and may occur again in the future. Under Schedule 2 of the *Country Areas Water Supply Act 1947*, a clearing licence is required prior to any clearing of native vegetation, except where exemptions apply.

One of the major risks to water quality associated with timber harvesting is turbidity. Undertaking good management practices for timber harvesting (such as retaining vegetation buffers along watercourses) can reduce soil erosion and therefore reduce turbidity levels in the water.

#### *Other activities*

In state forest, DEC allows certain activities that require a licence. These include apiarist activities (beekeeping), wildflower picking and seed collection. Although firewood collection is illegal in the Mungalup Dam Catchment Area, it does occur occasionally for private use. Any approval of these activities in the future will need to consider this protection plan to protect water quality. Public access to some parts of this catchment may be prevented under the *Country Areas Water Supply Act 1947*.

### 3.1.2 Mining

A mining lease (ML1SA) covers the Mungalup Dam Catchment Area. This state agreement tenement was granted to Alcoa of Australia in 1961. Under the *Alumina Refinery Agreement Act 1961*, Alcoa has rights to extract bauxite from areas of state forest covered by ML1SA with associated responsibilities to protect environmental values and rehabilitate mine sites. Alcoa has sub-leased part of ML1SA to Worsley Alumina Pty Ltd, including the part of the lease that covers the Mungalup Dam Catchment Area.

Worsley's mining operations are overseen by the Environmental Management Liaison Group, an inter-departmental committee on which the Department of Water is represented to ensure water quality protection objectives are met.

No mining activity has occurred in the catchment to date (see also section 3.2.1).

### 3.1.3 Recreation

Potential risks to water quality associated with recreational activities in the catchment include pathogen contamination, wildfire, turbidity, nutrients and inappropriate disposal of rubbish. Pathogens pose the most significant risk to public health. In water supplies, the pathogens of concern that can cause illness such as stomach upset and diarrhoea, are mostly found in the faeces of humans and domestic animals. Human and domestic animal contact with a water body increases the risk to drinking water quality. Treatment alone cannot be relied upon as the sole barrier to prevent pathogen contamination. However, treatment together with other risk avoidance, minimisation or management strategies is used effectively in Western Australia.

Recreation management in public drinking water source areas is guided by the Department of Water publicly consulted Statewide Policy No. 13: *Policy and guidelines for recreation within public drinking water source areas on crown land* (Water and Rivers Commission 2003). This policy is subject to review by government and, once completed, any changes to the policy will be reflected in this plan.

The Water Corporation conducts regular surveillance of this catchment and has been delegated power under the *Country Areas Water Supply Act 1947* to take enforcement action to protect water quality.

#### *Bibbulmun Track*

The Bibbulmun Track passes within metres of the reservoir. The Bibbulmun Track guide book (Department of Conservation and Land Management 2002b) advises walkers of the presence of the catchment and precautions to protect water quality.

The Bibbulmun Track will continue to pass through the Mungalup Dam Catchment Area, but the department is interested in investigating the potential for realignment of

the track further away and downstream of the water body and its feeder streams. Any investigations would be in consultation with all relevant agencies and user groups.

### *Camping*

Camping is an incompatible activity in the Mungalup catchment due to water quality risks (see Section 2). Evidence such as remnants of campfires, suggests that it occurs illegally around the reservoir.

### *Fishing, marroning and hunting*

Fishing, marroning and hunting are not supported by this department in the Mungalup Dam Catchment Area due to water quality risks (see Section 2). Water Corporation rangers conduct regular surveillance in the catchment area.

### *Off-road driving*

Evidence such as vehicle tracks seen below the high water mark suggests that illegal off-road driving, including trail bikes and motorbikes, occurs within the catchment, particularly on the reservoir banks with access via non-authorised established tracks.

Off-road driving is an incompatible activity within the Mungalup Dam Catchment Area due to the risk posed through turbidity, presence of people (pathogens) and potential accidents resulting in spills of fuels or oils.

### *Picnicking*

Picnicking is an incompatible activity in this catchment. There are no designated picnic sites in the catchment. However, illegal activity is known to occur on the reservoir banks, particularly on evenings and weekends, with evidence of fires and litter.

### *Swimming*

Swimming is prohibited in the Mungalup reservoir and surrounding catchment under the *Country Areas Water Supply Act 1947* by-laws and the Conservation and Land Management Regulations 2002, due to the unacceptable risk of pathogen contamination it poses to the drinking water source (see Section 2). However, illegal swimming does occur in the reservoir..

## **3.1.4 Native title**

Native title is a form of land title that recognises the unique ties some Aboriginal groups have to land. Native title exists where Aboriginal people have maintained a traditional connection to their land and waters since sovereignty, and where Acts of government have not removed it.

There is a native title claim within the proposed Mungalup Dam Catchment Area. This is the Gnaala Karla Booja (WAD6274\_98) claim.

## 3.2 Proposed land uses and activities

The land uses and activities identified in this plan are not expected to change in the short term. Future land uses need to be guided by this protection plan and recognise that the Mungalup Dam Catchment Area is protected under the *Country Areas Water Supply Act 1947*. This Act may restrict or prevent some land uses from occurring in the catchment to help protect water quality and public health. The Department of Environment and Conservation, the Water Corporation and the Department of Water need to coordinate land-use assessment and approvals in this catchment. Future land uses within the catchment are expected to be in accordance with the Department of Water's water quality protection note: *Land use compatibility in public drinking water source areas* and the Department of Water Statewide Policy No. 13: *Policy and guidelines for recreation within public drinking water source areas on crown land* (Water and Rivers Commission 2003). Please note that Policy 13 was published in 2003 and is currently subject to review.

### 3.2.1 Mining

Worsley Alumina, under a sub lease from Alcoa of Australia, have rights to extract bauxite from sites within the Mungalup Dam Catchment Area. Currently no mining is taking place, but Worsley Plan of Bauxite Mining Operations 2009-2018, indicates that exploratory drilling for mineral reserves will be carried within the catchment area in the future and therefore mining operations may take place in the catchment in the future. These operations will be overseen by the Environmental Management Liaison Group, of which the Department of Water is a member.

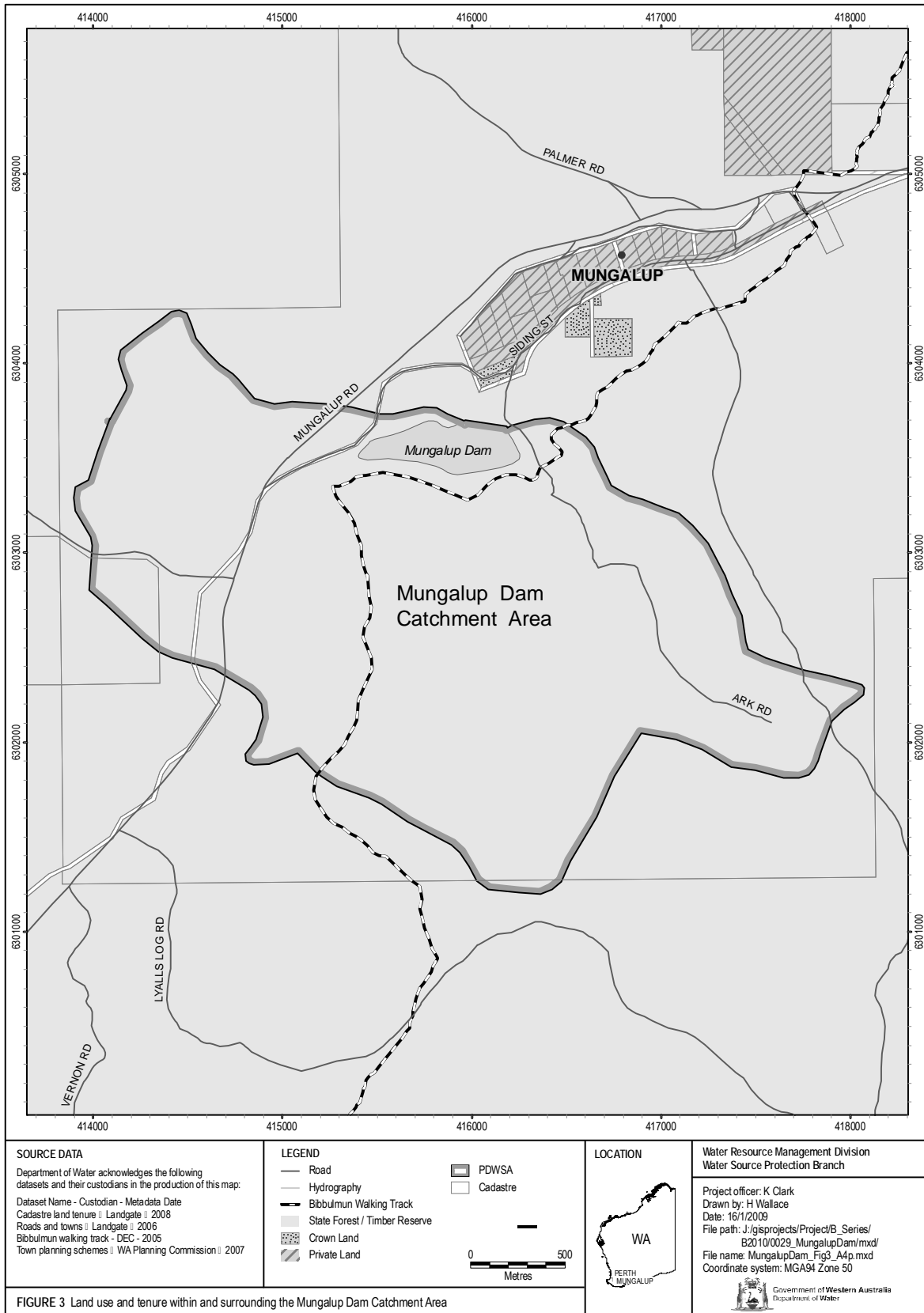


Figure 3 Land use and tenure within and surrounding the Mungalup Dam Catchment Area



Table 1 Land use/activity and hazards in Mungalup Dam Catchment Area

Land use/activity	Hazard	Management priority	Compatibility of land use/activity
<i>State forest</i>			
Roads and tracks	Hydrocarbons	LOW	Existing sealed roads are supported. Unsealed roads need to be managed to control access
	Turbidity	MEDIUM	
Drug crops	Pathogens	MEDIUM	Illegal activity
Native timber harvesting	Turbidity	LOW	Compatible with conditions in a P1 PDWSA
	Hydrocarbons	LOW	
	Pathogens	MEDIUM	
	Nutrients	LOW	
Resource harvesting <ul style="list-style-type: none"> <li>• apiarist</li> <li>• wildflower picking</li> <li>• seed collection</li> </ul>	Pathogens	MEDIUM	Compatible with conditions in a P1 PDWSA
Firewood collection	Pathogens	MEDIUM	There are no designated firewood collection areas in Mungalup Dam Catchment Area
	Hydrocarbons	LOW	
	Rubbish dumping	MEDIUM	
Fire management control <ul style="list-style-type: none"> <li>• prescribed burns</li> </ul>	Turbidity	LOW	Compatible with best management practices in a P1 PDWSA
Wildfire	Turbidity	MEDIUM/ HIGH	Not applicable
	Nutrients	LOW	
	Hydrocarbons	LOW	
	Chemicals	LOW	
	Decaying carcasses/ human presence	MEDIUM	
Feral animals and hunting	Pathogens	MEDIUM	Incompatible in a P1 PDWSA
	Turbidity	LOW	
	1080 baiting	LOW	
Mineral exploration	Hydrocarbons	LOW	Compatible with

Land use/activity	Hazard	Management priority	Compatibility of land use/activity
	Leaching of chemicals	LOW	conditions in a P1 PDWSA
Rubbish dumping	Leaching of pathogens	MEDIUM	Incompatible in a P1 PDWSA
	Leaching of nutrients	LOW	
	Leaching of chemicals	LOW	
<i>Recreation</i>			
Off-road vehicle use	Pathogens	MEDIUM	Incompatible in a P1 PDWSA
	Turbidity	MEDIUM	
	Hydrocarbons	MEDIUM	
Horse riding	Pathogens	HIGH	Incompatible in a P1 PDWSA with exceptions on designated trails and public roads
	Turbidity	LOW	
Swimming	Pathogens	HIGH	Incompatible in a P1 PDWSA
	Turbidity	LOW	
Fishing and marroning	Pathogens	HIGH	Incompatible in a P1 PDWSA
	Turbidity	MEDIUM	
Bushwalking and cycling	Pathogens	HIGH	Compatible with conditions in a P1 PDWSA
Picnicking	Pathogens	HIGH	Compatible with conditions in a P1 PDWSA in designated areas
	Turbidity	MEDIUM	
Camping	Pathogens	HIGH	Incompatible in a P1 PDWSA with exceptions in designated areas
	Turbidity	MEDIUM	

See Appendix B for an expansion of this table and proposed management strategies.

## 4 Catchment protection strategy

### 4.1 Protection objectives

The management objective for the Mungalup Dam Catchment Area is to preserve and protect the high quality of raw water for public drinking water supplies by avoiding the risk of contamination from inappropriate land uses and activities.

Appendix B recommends risk management measures for potential impacts on water quality at Mungalup Dam.

### 4.2 Proclaimed area

Mungalup Dam is located within the Wellington Dam Catchment Area which was proclaimed in 1957 under the *Country Areas Water Supply Act 1947*. This plan recommends that Mungalup Dam Catchment Area be proclaimed separately under the *Country Areas Water Supply Act 1947* to ensure an appropriate level of protection for this drinking water source.

Proclaiming the Mungalup Dam Catchment Area ensures that the *Country Areas Water Supply Act 1947* by-laws apply, and allows the Department of Water to manage potentially contaminating land uses and activities. The Mungalup Dam Catchment Area covers state forest and the Mungalup Dam (see Figure 2 and Figure 3).

### 4.3 Priority areas

The protection of PDWSAs relies on statutory measures available in legislation for land and water-resource management and land-use planning. The Department of Water's policy for the protection of PDWSAs includes three risk-based priority areas:

- Priority 1 (P1) areas have the fundamental water quality objective of risk avoidance.
- Priority 2 (P2) areas have the fundamental water quality objective of risk minimisation.
- Priority 3 (P3) areas have the fundamental water quality objective of risk management.

The determination of priority areas is based on the strategic importance of the land or water source, the local planning-scheme zoning, the form of land tenure and existing approved land uses or activities. For further detail, please refer to the Department of Water's water quality protection note: *Land use compatibility in public drinking water source areas*.

The proposed priority area for the Mungalup Dam Catchment Area has been determined in accordance with current Department of Water publicly consulted policy

and legislation. These areas are described below and displayed in Figure 4. The department's water quality protection note: *Land use compatibility in public drinking water source areas* outlines activities that are 'acceptable', 'compatible with conditions' or 'incompatible' within the different priority areas. For an explanation of the background and support for protection of PDWSAs, please refer to water quality protection note: *Protecting public drinking water source areas*.

It is proposed that the entire Mungalup Dam Catchment Area be managed for P1 source protection. This classification is appropriate as:

- it is currently being managed for P1 source protection as recommended in the drinking water source protection assessment (DWSPA)
- the existing water quality is of a generally high standard and therefore should be maintained and enhanced by assigning a high level of protection
- the land is under Crown ownership
- existing authorised land uses are generally considered compatible with P1 source protection objectives.

The P1 area is shown in Figure 4.

## 4.4 Protection zones

Protection zones are defined to protect drinking water sources from contamination in the immediate vicinity of water extraction facilities (e.g. bores or intake towers).

A Reservoir Protection Zone (RPZ) is proposed for Mungalup Dam. This area is shown in Figure 4. Public access is not recommended in this RPZ consistent with protection zones already established in the state. Public access is, however, acceptable within the RPZ when confined to public roads and designated tracks such as the Bibbulmun Track.

In order to address some concerns that reservoir protection zones could act to reduce the public health benefits of recreation, government is considering how best to review the issue of recreation in drinking water catchments. The review will consider the facts and allow government to determine what is best for Western Australia. The findings of that public review process will be incorporated into an update of this protection plan when it is completed.

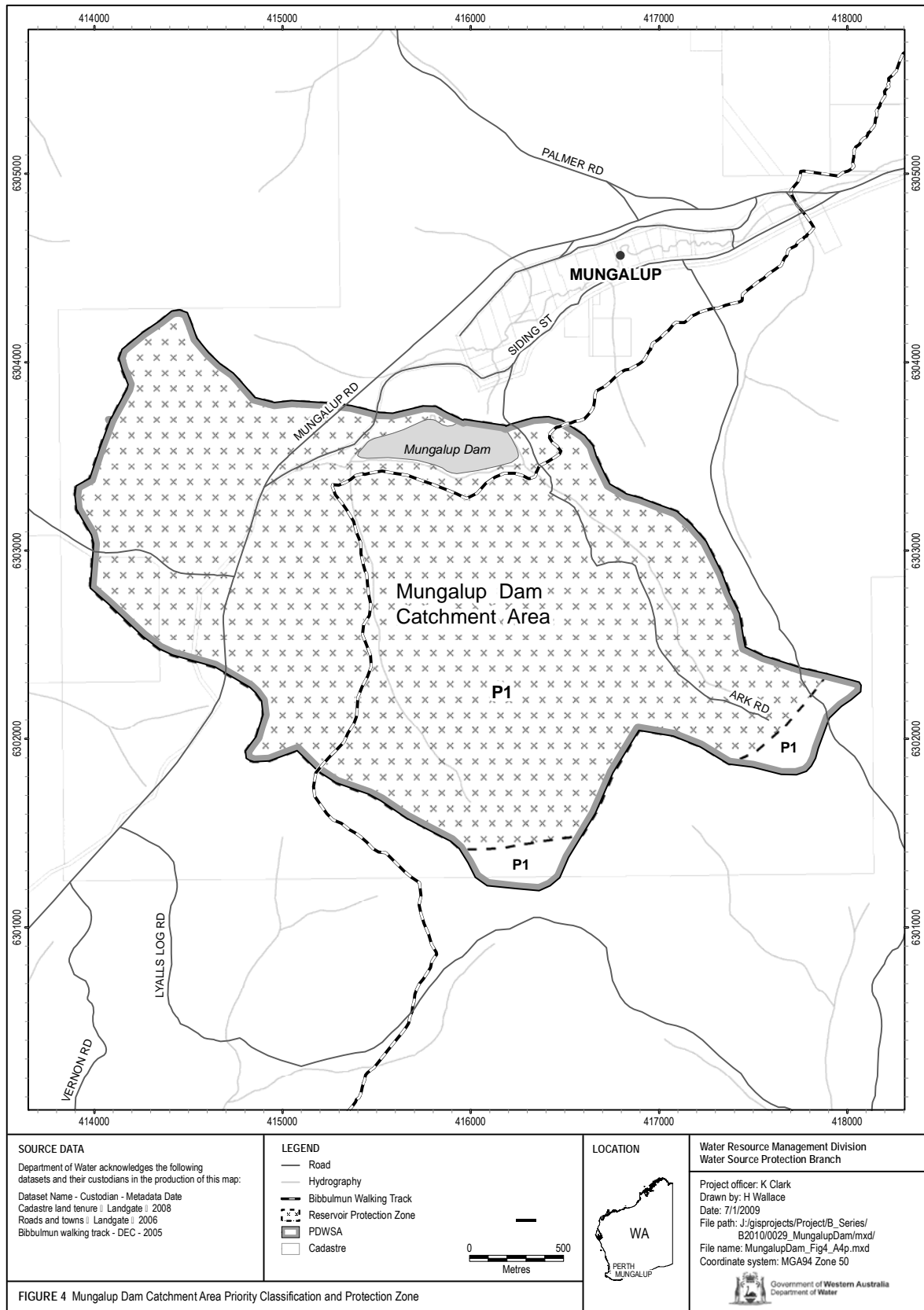


Figure 4 Mungalup Dam Catchment Area priority classification and protection zone

## 4.5 Land-use planning

The Department of Environment and Conservation has responsibilities for management planning over the majority of this catchment area under the *Conservation and Land Management Act 1984*.

Any development proposals within the Mungalup Dam Catchment Area that are inconsistent with advice in the Department of Water's water quality protection note: *Land use compatibility in public drinking water source areas*, Statewide Policy No. 13: *Policy and guidelines for recreation within public drinking water source areas on crown land* (Water and Rivers Commission 2003) or recommendations in this plan, should be referred to the Department of Water. For further information please refer to the Department of Water's water quality protection note: *Protecting public drinking water source areas*.

The department's protection strategy for public drinking water source areas (PDWSA) provides for lawfully established and operated developments to continue, despite those facilities posing a potential level of risk to water quality which would not be accepted for new developments. The department may negotiate with landowners/operators on measures to improve these facilities and reduce water quality contamination risks.

In strategically significant areas, the department has developed a policy that allows it to approach land owners with a view to purchase land or negotiate water contamination risk reduction measures.

## 4.6 Best management practices

There are opportunities to significantly reduce water contamination risks by carefully considering design and management practices. The adoption of best management practices for land uses will continue to be encouraged to help protect water sources.

There are guidelines for many land uses available in the form of industry codes of practice, environmental guidelines and water quality protection notes. These have been developed in consultation with stakeholders such as industry groups, agricultural producers, state government agencies and technical advisers. Examples include *Code of practice for timber harvesting in Western Australia* (Department of Conservation and Land Management 1999); Statewide Policy No. 13: *Policy and guidelines for recreation within public drinking water source areas on crown land* (Water and Rivers Commission 2003); Policy Statement No.18: *Recreation, Tourism and Visitor Services* (Department of Environment and Conservation 2007); and Statewide Policy No. 2: *Pesticide use in public drinking water source areas* (Water and Rivers Commission 2000), which are listed in the *Bibliography* section of this document. The guidelines help managers reduce the water quality impacts of their operations and are recommended to ensure the protection of water quality.

Education and creating awareness (e.g. signage and information) are also key mechanisms for protecting the quality of water, especially for those people visiting the area who are unfamiliar with the Mungalup Dam Catchment Area. A brochure will be produced once this plan is endorsed, describing the Mungalup Dam Catchment Area, its location and the main threats to water quality. This brochure will be available to the community and will inform people in simple terms of the drinking water source and the need to protect it.

## 4.7 Surveillance and by-law enforcement

The quality of drinking water in country areas of the state is protected under the *Country Areas Water Supply Act 1947*. This Act allows for the proclamation of PDWSAs and application of the by-laws to protect water quality.

The Department of Water considers by-law enforcement, through surveillance of land-use activities in PDWSAs, as an important mechanism to protect water quality.

Signs are erected on the boundaries of PDWSAs to educate and to advise the public of activities that are prohibited or regulated. This plan recommends that the existing delegation of surveillance and by-law enforcement to the Water Corporation be continued.

## 4.8 Emergency response

The escape of contaminants during unforeseen incidents and the use of chemicals during emergency responses can result in water contamination. The Shire of Collie's local emergency management committee (LEMC), through the South West emergency management district, should be familiar with the location and purpose of the Mungalup Dam Catchment Area. A locality plan should be provided to the fire and rescue services headquarters for the hazardous materials (HAZMAT) emergency advisory team. DEC is the lead agency for wildfire control management for the majority of the catchment area that is outside of the gazetted fire emergency response zone. The Water Corporation should have an advisory role for all incidents in the Mungalup Dam Catchment Area that may result in contamination of the reservoir.

Personnel who deal with WESTPLAN – HAZMAT (Western Australian plan for hazardous materials) incidents within the area should have access to a map of the Mungalup Dam Catchment Area. These personnel should have an adequate understanding of the potential impacts of spills on this water resource.

## 4.9 Implementation of this plan

Table 1 identifies the potential water quality risks associated with existing land uses in the Mungalup Dam Catchment Area. Further information and recommended protection strategies to deal with these risks are outlined in Appendix B.

Following completion of the *Mungalup Dam Catchment Area drinking water source protection plan*, an implementation strategy will be drawn up based on the recommendations in this plan. It will aim to provide an indicative timeframe for the recommended protection strategies and identify stakeholders that could be involved in implementation actions.



## 5 Recommendations

The following recommendations apply to the entire Mungalup Dam Catchment Area. The bracketed stakeholders are those expected to have a direct interest in implementation of the relevant recommendation.

- 1 The boundary of the Mungalup Dam Catchment Area should be proclaimed under the *Country Areas Water Supply Act 1947*. (Department of Water)
- 2 Develop an implementation strategy for the recommendations of this plan (including the recommended protection strategies as detailed in Appendix B) showing key stakeholders and planned timeframes. (Department of Water, applicable stakeholders)
- 3 All development proposals or land uses within the Mungalup Dam Catchment Area that are inconsistent with the Department of Water's water quality protection note: *Land use compatibility in public drinking water source areas*, recommendations in this plan or Statewide Policy No. 13: *Policy and guidelines for recreation within public drinking water source areas on crown land* (Water and Rivers Commission 2003), should be referred to the Department of Water for advice and recommendations. (Department of Environment and Conservation, Water Corporation, applicable stakeholders)
- 4 Incidents covered by WESTPLAN – HAZMAT in the Mungalup Dam Catchment Area should be addressed by ensuring that:
  - the Shire of Collie LEMC should be aware of the location and purpose of the Mungalup Dam Catchment Area
  - the locality plan for the Mungalup Dam Catchment Area is provided to the Fire & Emergency Services Authority headquarters for the HAZMAT emergency advisory team
  - the Water Corporation acts in an advisory role during incidents in the Mungalup Dam Catchment Area
  - personnel dealing with WESTPLAN – HAZMAT incidents in the area have ready access to a locality map of the Mungalup Dam Catchment Area and information to help them recognise the potential impacts of spills on drinking water quality.(Water Corporation and Department of Water)
- 5 The existing monitoring and surveillance program should be maintained to identify any incompatible land uses or potential threats within the Mungalup Dam Catchment Area. (Department of Water, Water Corporation)
- 6 More signs should be erected along the boundary of the Mungalup Dam Catchment Area to define the location and promote awareness of the need to protect drinking water quality. Signs should include an emergency contact telephone number. (Water Corporation)
- 7 Any management plans produced by the Department of Environment and Conservation which incorporate the Mungalup Dam Catchment Area should be

referred to the Department of Water for advice and recommendations.  
(Department of Environment and Conservation)

- 8 Investigate the closure of unnecessary roads and tracks, and the gating of access to other roads to prevent public access to the Mungalup reservoir. (Water Corporation, Department of Environment and Conservation)
- 9 Investigate the potential to realign the Bibbulmun Track to reduce significant risks to the water quality. (Department of Water, Department of Environment and Conservation, the Bibbulmun Track Foundation)
- 10 A review of this plan should be undertaken after five years. (Department of Water)

# Appendices

## Appendix A Water quality data

The information provided in this appendix has been prepared by the Water Corporation.

The Water Corporation has monitored the raw (source) water quality from Mungalup Dam. This data shows the quality of water in the catchment. An assessment of the drinking water quality is also made in accordance with the National water quality management strategy: *Australian drinking water guidelines 6, 2004 (ADWG)* (NHMRC & NRMCC 2004a) and interpretations agreed to with the Department of Health. The raw water is monitored regularly for:

- aesthetic characteristics (non-health-related)
- health-related characteristics including
  - health-related chemicals
  - microbiological contaminants

The following data are representative of the quality of raw water from Mungalup Dam. In the absence of specific guidelines for raw water quality, the results have been compared with the ADWG values set for drinking water, which defines the quality requirements at the customer's tap. Results that exceed the ADWG have been shaded to give an indication of potential raw water quality issues associated with this source.

It is important to appreciate that the raw water data presented does not represent the quality of drinking water distributed to the public. Barriers such as storage and water treatment exist downstream of the raw water to ensure it meets the requirements of the ADWG. The values are taken from ongoing monitoring for the period September 2003 to August 2008.

Any water quality parameters that have been detected are reported; those that on occasion have exceeded the ADWG are shaded.

For more information on the quality of drinking water supplied to the Collie and Mungalup regions refer to the most recent Water Corporation drinking water quality annual report at <[www.watercorporation.com.au](http://www.watercorporation.com.au)> > Publications > Water quality > Latest annual report.

## Aesthetic

The aesthetic quality analyses for raw water from Mungalup Dam are summarised in the following table.

### *Aesthetic detections for Mungalup Dam*

Parameter	Units	ADWG aesthetic guideline value*	Mungalup Dam	
			Range	Median
Aluminium (unfiltered)	mg/L	NA	0.008–0.024	0.036
Colour (true)	TCU	15	<1–7	3
Conductivity at 25°C	mS/m	NA	17–28	21
Hardness as CaCO <sub>3</sub>	mg/L	200	17.9–21	19
Iron unfiltered	mg/L	0.3	0.026–0.8	0.08
pH measured in laboratory	no unit	6.5–8.5	6.61–7.71	7.375
Sodium	mg/L	180	24–31	27
Sulphate	mg/L	250	6–7	6.5
TFSS	mg/L	500	97–122	107
Turbidity	NTU	5	0.3–7.6	0.75

\* An aesthetic guideline value is the concentration or measure of a water quality characteristic that is associated with good quality water.

Raw water from Mungalup Dam is of good quality with only iron concentrations occasionally in excess of the ADWG aesthetic guideline. The raw water is fluoridated and disinfected prior to supply as drinking water.

## Health related

### *Health-related chemicals*

Raw water from Mungalup Dam is analysed for chemicals that are harmful to human health, including categories of chemicals such as inorganics, heavy metals, industrial hydrocarbons and pesticides. Health-related parameters that impact on water quality are summarised in the following table.

### Health-related detections for Mungalup Dam

Parameter	Units	ADWG health guideline value*	Mungalup Dam	
			Range	Median
Barium <sup>†</sup>	mg/L	0.7	0.0045	0.0045
Manganese unfiltered	mg/L	0.1	0.002–0.65	0.01
Nitrate as nitrogen	mg/L	11.29	0.003–0.018	0.005
Nitrite as nitrogen	mg/L	0.91	<0.002–0.012	<0.003
Tributyltin oxide <sup>†</sup>	mg/L	1	<0.02–0.003	<0.0025

\* A health guideline value is the concentration or measure of a water quality characteristic that, based on present knowledge, does not result in any significant risk to the health of the consumer over a lifetime of consumption (NHMRC & ARMCANZ 2004a).

<sup>†</sup> Water quality data observed from three or less sampling occasions.

### Microbiological contaminants

Microbiological testing of raw water samples from Mungalup Dam is currently conducted weekly. *Escherichia coli* counts are used as an indicator of the degree of recent faecal contamination of the raw water from warm-blooded animals. A count of less than 20 MPN (most probable number) per 100 mL sample is typically associated with low levels of faecal contamination and is used as a microbiological contamination benchmark of the raw water (WHO 2004). As such, counts less than 20 MPN are seen as being an indication of raw water that has not been recently contaminated with faecal material.

During the reviewed period, positive *Escherichia coli* counts were recorded in 49.5 per cent of samples. Approximately 2.5 per cent of the positive samples had *Escherichia coli* counts greater than 20 MPN/100 mL. This can be explained by activities within the catchment and the size of the reservoir.

The raw water is disinfected with chlorine to ensure the microbiological quality of the drinking water supplied to customers is adequate. The Collie South and Mungalup town water supply has complied with ADWG microbiological requirements.

## Appendix B Land use, potential water quality risks and recommended protection strategies

This table was prepared from data in Section 3 of this plan.

Land use/activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
<i>State forest</i>					
Roads and tracks	Hydrocarbons and chemicals from fuel and chemical spills	LOW	Mungalup Road, a sealed rural access road, passes through the western side of the catchment 500 m from the reservoir. Traffic levels are generally low.  The catchment also contains numerous gravel tracks providing direct access to the western and eastern reservoir banks (see Figure B2 in Appendix B). The condition of the tracks also suggests usage is greatest on and near the reservoir banks with erosion contributing to turbidity.	<ul style="list-style-type: none"> <li>• DEC management of state forest tracks</li> <li>• Shire management of roads</li> <li>• HAZMAT emergency response procedures</li> <li>• Detention time in the reservoir</li> <li>• Water quality monitoring</li> </ul>	<ul style="list-style-type: none"> <li>• Close unused roads</li> <li>• Install gates to other roads that currently provide public access</li> <li>• Use pesticides in accordance with Department of Health's PSC 88</li> </ul>
	Turbidity from erosion and runoff	MEDIUM			
	Pathogens from rubbish dumping	MEDIUM			
	Herbicides from road verge weed control	LOW			
Illegal drug crops	Pathogens from human	MEDIUM	Drug growing is known to occur in the area; crops are removed when	<ul style="list-style-type: none"> <li>• WC and DEC monitoring</li> <li>• Detention time in the</li> </ul>	<ul style="list-style-type: none"> <li>• Increase surveillance and improve</li> </ul>

Land use/activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
	and animal activity		identified.	reservoir <ul style="list-style-type: none"> <li>Water quality monitoring</li> </ul>	communication between WC, DEC and the WA Police
Native timber harvesting	Turbidity from erosion and runoff	LOW	As state forest, the area is available for periodic timber harvesting during which vegetation density over portions of the area may be reduced and/or regeneration initiated. No harvest operations are planned during the current three-year harvest plan period 2008–10. Harvesting operations are guided by the <i>Forest management plan 2004–13</i> (Conservation Commission of Western Australia 2003) and subsidiary documents such as the <i>Interim manual of procedures for management of soils associated with</i>	<ul style="list-style-type: none"> <li>Water Corporation (WC) and DEC surveillance</li> <li>FPC codes of practice and EMS</li> <li>Detention time in the reservoir</li> <li>Water quality monitoring</li> <li><i>Country Areas Water Supply Act 1947</i> clearing controls</li> </ul>	<ul style="list-style-type: none"> <li>Increase surveillance and monitoring in harvested areas</li> <li>Increase training and awareness of staff with relation to water quality issues such as maintenance or degradation</li> <li>Ensure adequate buffers are in place</li> <li>DEC refers any proposed best management practice documents in timber</li> </ul>
	Hydrocarbons from fuel spills and leaks from forestry vehicles	LOW			

Land use/activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
	Pathogens from human activity	MEDIUM	<p><i>timber harvesting in native forests</i> (Department of Environment and Conservation 2007), which include guidelines for the protection of water. Operations are supervised by the Forests Products Commission (FPC), which operates in accordance with an environmental management system (EMS), and with surveillance and monitoring by DEC.</p> <p>The Wellington Dam Catchment Area (which includes the Mungalup Dam Catchment Area) is a clearing control catchment and therefore restrictions apply to the clearing of native vegetation.</p>		<p>harvesting to the Department of Water for advice and input</p> <ul style="list-style-type: none"> <li>Require a <i>Country Areas Water Supply Act 1947</i> licence to clear permit prior to any native vegetation clearing</li> </ul>
	Nutrients from fertilising prior to replanting	LOW			
<p>Resource harvesting</p> <ul style="list-style-type: none"> <li>apiarist</li> <li>wildflower picking</li> <li>seed collection</li> </ul>	Pathogens from human activity	MEDIUM	<p>Activities and numbers are effectively managed by DEC through issuing of licences under the Forest Management Regulation 1993 (Apiarists) and the Wildlife Conservation Regulations 1970 (Flora). There are currently no permitted apiary sites in the catchment.</p>	<ul style="list-style-type: none"> <li>DEC regulations</li> <li>Detention time in the reservoir</li> <li>Water quality monitoring</li> <li>DEC permits required to undertake these activities</li> </ul>	<ul style="list-style-type: none"> <li>DEC ensures that permits contain adequate water quality protection measures</li> </ul>



Land use/activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
			There is the potential for unauthorised activity and people accessing tributaries or the water body.		
Firewood collection	Pathogens from human and domestic animal activity	MEDIUM	Free firewood for domestic purposes can be gathered without a licence from certain areas of state forest; vehicles are required to stay on existing roads. DEC produces firewood collection guidelines. detailing designated firewood collection sites.	<ul style="list-style-type: none"> <li>• DEC collection guidelines</li> <li>• Forest Management Regulations 1993 and <i>Country Areas Water Supply Act 1947</i> by-laws</li> <li>• WC and DEC monitoring</li> <li>• Detention time in the reservoir</li> <li>• Water quality monitoring</li> </ul>	<ul style="list-style-type: none"> <li>• Increase monitoring and signage</li> <li>• Promote legal collection in areas outside the catchment</li> <li>• Enforce no firewood collection in the catchment area</li> </ul>
	Waste dumping: hydrocarbons from machinery	LOW			
	Vehicles: hydrocarbons	LOW	There is the potential for people to be close to tributaries.		
	Rubbish dumping	MEDIUM	Hydrocarbon waste and increased wildfire risk from off road vehicles use can be associated with public firewood collection.		
Fire management control	Turbidity from erosion from fire control line	LOW	Fire management in the state forest is the responsibility of DEC. Water quality issues are considered in fire	<ul style="list-style-type: none"> <li>• DEC management</li> <li>• Detention time in the reservoir</li> </ul>	<ul style="list-style-type: none"> <li>• FPC and DEC apply appropriate standards for construction of fire</li> </ul>

Land use/activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
<ul style="list-style-type: none"> <li>Prescribed burns</li> </ul>	and stripping of vegetation due to fire		management operations. Turbidity resulting from prescribed burns is less than for wildfire as burn intensity is much lower.	<ul style="list-style-type: none"> <li>Water quality monitoring</li> </ul>	<ul style="list-style-type: none"> <li>control lines</li> <li>WC monitors water quality at correct timing during and after burns</li> </ul>
Wildfire	Turbidity from erosion from fire breaks and stripping of vegetation due to fire	MEDIUM	Fire management in the state forest is the responsibility of DEC. Water quality issues are considered in fire management operations. The WC adheres to post-event management procedures.  Mungalup fire tower (which is occupied by DEC during the fire season) is located at the top of the catchment.	<ul style="list-style-type: none"> <li>DEC prescribed burning and other management</li> <li>WC participation during major fires and post fire management</li> <li>Detention time in the reservoir</li> <li>Water quality monitoring</li> </ul>	<ul style="list-style-type: none"> <li>Continue current fire management regime</li> <li>WC monitors water quality post wildfire</li> <li>Streamline and reservoir buffers are considered before applying chemical fire suppressors</li> <li>Other water sources in the area are used at a water point for firefighting in preference to the reservoir</li> </ul>
	Nutrients from firefighting foam	LOW			
	Hydrocarbons from water point use and contamination of water body	LOW			
	Chemicals from decomposition of vegetation/ breakdown of soil	LOW			

Land use/activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
	Pathogens from decaying carcasses/ human presence	MEDIUM			
Feral animals and hunting	Pathogens from faecal contamination/ carcasses	MEDIUM	<p>There is the potential for pathogen contamination of tributaries and the reservoir from animal carcasses, faeces and wallowing. Pigs occur in the catchment; reintroduction by hunters is known to occur. Pig hunting is a popular recreational activity with hunters using dogs.</p> <p>DEC has found evidence of kangaroo hunting occurring in the area, finding a number of kangaroo carcasses that had been killed by gunfire.</p> <p>DEC is responsible for feral animal control programs in the catchment. 1080, a naturally occurring chemical that poses low risk to water quality, is used to control foxes. Baits must not be placed within 100 m of</p>	<ul style="list-style-type: none"> <li>• WC and DEC monitoring</li> <li>• Detention time in the reservoir</li> <li>• Water quality monitoring</li> </ul>	<ul style="list-style-type: none"> <li>• DEC maintains 1080 baiting for foxes</li> <li>• DEC maintains trapping for feral pigs</li> <li>• Increase monitoring and by-law enforcement</li> </ul>
	Turbidity from wallowing	LOW			
	Pathogens from human presence: hunting/ trapping	MEDIUM			
	1080 baiting	LOW			

Land use/activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
			watercourses or reservoirs.		
Rubbish dumping	Leaching of pathogens	MEDIUM	Minimal rubbish dumping currently occurs in the catchment. The level of dumping could increase if the shire were to start charging to use the local refuse site.	<ul style="list-style-type: none"> <li>• WC and DEC monitoring</li> <li>• Detention time in the reservoir</li> <li>• Water quality monitoring</li> <li>• Illegal dumping is controlled by the <i>Litter Act 1979</i></li> </ul>	<ul style="list-style-type: none"> <li>• Increase monitoring and signage</li> <li>• DEC enforces its regulations</li> </ul>
	Leaching of nutrients	LOW			
	Leaching of chemicals	LOW			
Mineral exploration	Hydrocarbons fuel leaks and spills	LOW	Mining tenements are subject to licensing by the Department of Mines and Petroleum (DMP). The DMP and the Department of Water have an administrative agreement in place to manage mining activities to protect public drinking water source areas (and other water resources).	<ul style="list-style-type: none"> <li>• DMP mining tenement licence conditions</li> <li>• Water quality monitoring</li> </ul>	<ul style="list-style-type: none"> <li>• Ensure adherence to mining and mineral processing guidelines</li> <li>• Ensure compliance with tenement licence conditions</li> </ul>
	Leaching of chemicals	LOW			
<i>Recreation</i>					
Off-road vehicle use	Pathogens from human activity	MEDIUM	Off-road vehicle use in the catchment occurs predominantly on the reservoir banks with access via established tracks. There is	<ul style="list-style-type: none"> <li>• WC monitoring</li> <li>• Limited signage and fencing</li> </ul>	<ul style="list-style-type: none"> <li>• Increase monitoring and signage</li> <li>• Install locked gates on access tracks to the</li> </ul>

Land use/activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
	Turbidity due to erosion from vehicles	MEDIUM	considerable localised erosion, which provides a source of turbidity (See Figure B2 in Appendix B). Refuelling in the catchment would not be common due to the proximity to Collie. The boom gate at the north-eastern end and stock fence on northern side restrict access.	<ul style="list-style-type: none"> <li>• Detention time in the reservoir</li> <li>• Water quality monitoring</li> </ul>	<ul style="list-style-type: none"> <li>• water body</li> <li>• Close non-essential roads</li> <li>• Engage recreational user groups</li> </ul>
	Hydrocarbons from fuel spills and refuelling/accidents	MEDIUM			
Horse riding	Pathogens from human and animal activity	HIGH	Direct contact of animals with waterways and the water body poses the greatest risk. Horse riding on established (public) roads and tracks poses a reduced risk and is an authorised activity in state forest and PDWSAs, but not in a reservoir protection zone (RPZ).	<ul style="list-style-type: none"> <li>• WC monitoring</li> <li>• Detention time in the reservoir</li> <li>• Water quality monitoring</li> </ul>	<ul style="list-style-type: none"> <li>• A majority of Mungalup Dam Catchment Area is proposed as a RPZ; therefore horse riding is incompatible in this area (except on public roads)</li> <li>• Increase monitoring, by-law enforcement and signage</li> </ul>
	Turbidity due to erosion from animals	LOW			

Land use/activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Swimming	Pathogens from human and domestic animal contact with water	HIGH	Human or animal contact with water involves an immediate threat to water quality with the potential for pathogen contamination. Swimming is prohibited in Mungalup Dam. However, some swimming does occur, mainly during summer. The reservoir is easily accessible with limited signage and fencing at the dam wall. The effectiveness of the existing preventative strategies in minimising risk is low.	<ul style="list-style-type: none"> <li>• WC monitoring</li> <li>• Limited signage and fencing</li> <li>• Water quality monitoring</li> </ul>	<ul style="list-style-type: none"> <li>• Increase monitoring, by-law enforcement and signage</li> <li>• Conservation and Land Management Regulation to prohibit swimming</li> <li>• Close some roads and tracks to prevent unauthorised access</li> </ul>
	Turbidity from erosion of reservoir banks	LOW	Detention time cannot be considered an effective barrier for reducing the risk associated with direct contact with the water body, i.e. microbiological contamination.		
Fishing and marroning	Pathogens from human activity, contact with water and use of bait	HIGH	Human or animal contact with water involves an immediate threat to water quality with the potential for pathogen contamination. There are low levels of fishing and marroning in the reservoir with marron numbers reported to be low	<ul style="list-style-type: none"> <li>• WC monitoring</li> <li>• Limited signage and fencing</li> <li>• Water quality monitoring</li> </ul>	<ul style="list-style-type: none"> <li>• Increase monitoring by WC and Department of Fisheries</li> <li>• Close some roads and tracks to prevent unauthorised access in conjunction with land</li> </ul>

Land use/activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
	Turbidity from the erosion of reservoir and stream banks	MEDIUM	<p>since the reservoir was drained at the beginning of 2007 for construction purposes. The reservoir is easily accessible with limited signage and fencing at the dam wall.</p> <p>Detention time cannot be considered an effective barrier for reducing the risk associated with direct contact with the water body.</p>		<p>managers</p> <ul style="list-style-type: none"> <li>Engage recreational user groups</li> </ul>
Bushwalking and cycling	Pathogens from human and domestic animal activity	HIGH	<p>The Bibbulmun Track passes within metres of the reservoir. Track notes inform walkers of the presence of the catchment and precautions to protect water quality. There are no toilets or camping facilities provided in the catchment. Medium levels of activity are reported.</p>	<ul style="list-style-type: none"> <li>WC and DEC monitoring</li> <li>Limited signage and fencing</li> <li>Bibbulmun Track notes</li> <li>Detention time in the reservoir</li> <li>Water quality monitoring</li> </ul>	<ul style="list-style-type: none"> <li>Increase signage informing tourists/ bushwalkers not to access the water body</li> <li>Increase monitoring</li> <li>Close some roads to prevent unauthorised access</li> <li>Investigate potential realignment of the Bibbulmun Track given current proximity to the reservoir and body contact with water</li> </ul>

Land use/activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Picnicking and camping	Pathogens from human and domestic animal activity	HIGH	There are no designated camping or picnicking sites in the catchment. Illegal activity is known to occur on the reservoir banks, with evidence of fires and litter.  Picnicking and camping in non-designated areas is prohibited.	<ul style="list-style-type: none"> <li>• WC and DEC monitoring</li> <li>• Limited signage and fencing</li> <li>• Detention time in the reservoir</li> <li>• Water quality monitoring</li> </ul>	<ul style="list-style-type: none"> <li>• Increase signage informing tourists/ bushwalkers not to access the water body</li> <li>• Increase monitoring.</li> <li>• DEC promotes use of designated campsites and discourages illegal camping</li> <li>• Close some roads and tracks to prevent unauthorised access</li> </ul>
	Turbidity from erosion by vehicles	MEDIUM			



## Appendix C Photographs



*Figure B1 Mungalup Dam (photograph taken by Kellie Clark)*



*Figure B2 Mungalup Dam showing low water levels due to dam construction. Note evidence of four-wheel driving on banks (photograph taken by Kellie Clark)*



## Acronyms and abbreviations

<b>ADWG</b>	<i>Australian drinking water guidelines</i>
<b>AHD</b>	Australian height datum
<b>ANZECC</b>	Australian and New Zealand Environment Conservation Council
<b>ARMCANZ</b>	Agriculture and Resource Management Council of Australia and New Zealand
<b>DEC</b>	Department of Environment and Conservation
<b>GL</b>	gigalitre
<b>ha</b>	hectare
<b>HAZMAT</b>	hazardous materials
<b>kL</b>	kilolitre
<b>km</b>	kilometre
<b>km<sup>2</sup></b>	square kilometre
<b>LEMC</b>	local emergency management committee
<b>m</b>	metres
<b>mg/L</b>	milligram per litre
<b>mL</b>	millilitre
<b>ML</b>	megalitre
<b>mm</b>	millimetre
<b>MPN</b>	most probable number
<b>mSv</b>	millisievert
<b>mS/m</b>	millisiemens per metre
<b>NHMRC</b>	National Health and Medical Research Council
<b>NRMMC</b>	Natural Resource Management Ministerial Council
<b>NTU</b>	nephelometric turbidity units
<b>PSC 88</b>	public sector circular number 88
<b>PDWSA</b>	public drinking water source area

<b>RPZ</b>	reservoir protection zone
<b>TCU</b>	true colour units
<b>TDS</b>	total dissolved solids
<b>TFSS</b>	total filterable solids by summation
<b>WC</b>	Water Corporation
<b>WESTPLAN – HAZMAT</b>	Western Australian plan for hazardous materials

## Glossary

<b>Abstraction</b>	The pumping of groundwater from an aquifer, or the removal of water from a waterway or water body.
<b>Adsorb</b>	Adsorb means to accumulate on the surface of something. For example, micro-organisms can adsorb onto soil particles.
<b>Australian drinking water guidelines</b>	The <i>National water quality management strategy: Australian drinking water guidelines 6, 2004</i> (NHMRC & NRMMC 2004a) (ADWG) outline acceptable criteria for the quality of drinking water in Australia (see <i>Bibliography</i> section).
<b>Aesthetic guideline value</b>	Is the concentration or measure of a water quality characteristic that is associated with acceptability of water to the consumer, e.g. appearance, taste and odour (NHMRC & NRMMC 2004a).
<b>Australian height datum</b>	Australian height datum is the height of land in metres above mean sea level. For example, the AHD is +0.026 m at Fremantle.
<b>Allocation</b>	The quantity of water permitted to be abstracted by a licensee is their allocation, usually specified in kilolitres per annum (kL/a).
<b>Catchment</b>	The physical area of land which intercepts rainfall and contributes the collected water to surface water (streams, rivers, wetlands) or groundwater is referred to as a catchment.
<b>Department of Environment and Conservation</b>	The Department of Environment and Conservation was established on 1 July 2006, bringing together the Department of Environment and the Department of Conservation and Land Management.
<b>Effluent</b>	Effluent is treated or untreated liquid, solid or gaseous waste discharged by a process, such as through a septic tank and leach drain system.
<b>Gigalitre</b>	A gigalitre is equivalent to 1 000 000 000 litres or one million kilolitres.
<b>Hectare</b>	A hectare is a measurement of area, equivalent to 10 000 square metres.
<b>Health guideline value</b>	Is the concentration or measure of a water quality characteristic that, based on current knowledge, does not result in any significant risk to the health of the consumer over a lifetime of consumption (NHMRC & NRMMC 2004a).

<b>Hydrocarbons</b>	A class of compounds containing only hydrogen and carbon, such as methane, ethylene, acetylene and benzene. Fossil fuels such as oil, petroleum and natural gas all contain hydrocarbons.
<b>Intake Tower</b>	A structure, the purpose of which is to control, regulate, divert and admit water directly from the source.
<b>Leaching/leachate</b>	The process by which materials such as organic matter and mineral salts are washed out of a layer of soil or dumped material by being dissolved or suspended in percolating rainwater. The material washed out is known as leachate. Leachate can pollute groundwater and waterways.
<b>mg/L</b>	A milligram per litre (0.001 grams per litre) is a measurement of a total dissolved solid in a solution.
<b>Most probable number</b>	Most probable number is a measure of microbiological contamination.
<b>Millisievert</b>	A millisievert is a measure of annual radiological dose, with a natural dose equivalent to 2 mSv/yr.
<b>Millisiemens per metre</b>	Millisiemens per metre is a measure of electrical conductivity of a solution or soil and water mix that provides a measurement of salinity.
<b>Nephelometric turbidity units</b>	Nephelometric turbidity units are a measure of turbidity in water.
<b>Nutrients</b>	Minerals, particularly inorganic compounds of nitrogen (nitrate and ammonia) and phosphorous (phosphate) dissolved in water which provides nutrition (food) for plant growth.
<b>Pathogen</b>	A disease-producing organism that can cause sickness and sometimes death through the consumption of water, including bacteria (such as <i>Escherichia coli</i> ), protozoa (such as <i>Cryptosporidium</i> and <i>Giardia</i> ) and viruses.
<b>Pesticides</b>	Collective name for a variety of insecticides, fungicides, herbicides, algicides, fumigants and rodenticides used to kill organisms.
<b>pH</b>	A logarithmic scale for expressing the acidity or alkalinity of a solution. A pH below seven indicates an acidic solution and above seven indicates an alkaline solution.

<b>Pollution</b>	Water pollution occurs when waste products or other substances (effluent, litter, refuse, sewage or contaminated runoff) change the physical, chemical or biological properties of the water, adversely affecting water quality, living species and beneficial uses.
<b>Public sector circular number 88</b>	A state government circular produced by the Department of Health providing guidance on appropriate herbicide use within water catchment areas.
<b>Public drinking water source area</b>	Includes all underground water pollution control areas, catchment areas and water reserves constituted under the <i>Metropolitan Water Supply Sewerage and Drainage Act 1909</i> and the <i>Country Areas Water Supply Act 1947</i> .
<b>Recharge</b>	Recharge is the action of water infiltrating through the soil/ground to replenish an aquifer.
<b>Recharge area</b>	An area through which water from a groundwater catchment percolates to replenish (recharge) an aquifer. An unconfined aquifer is recharged by rainfall throughout its distribution. Confined aquifers are recharged in specific areas where water leaks from overlying aquifers, or where the aquifer rises to meet the surface.
<b>Reservoir</b>	A reservoir, dam, tank, pond or lake that forms part of any public water supply works.
<b>Reservoir protection zone</b>	An area measured two km from the high water mark of a drinking water reservoir, back into a catchment and inclusive of the reservoir. This is referred to as a prohibited zone under the Metropolitan Water Supply, Sewerage and Drainage Act By-laws 1981.
<b>Riparian vegetation</b>	Vegetation growing within the channel and along the banks of waterways, extending laterally away from the bank and ending at the extent of the floodplain.
<b>Runoff</b>	Water that flows over the surface from a catchment area, including streams.
<b>Scheme supply</b>	Water diverted from a source or sources by a water authority or private company and supplied via a distribution network to customers for urban, industrial use or for irrigation.
<b>Stormwater</b>	Rainwater which has run off the ground surface, roads, paved areas etc, and is usually carried away by drains.
<b>True colour units</b>	True colour units are a measure of degree of colour in water.

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<b>Total dissolved solids</b>	Total dissolved solids consist of inorganic salts and small amounts of organic matter that are dissolved in water. Clay particles, colloidal iron and manganese oxides, and silica fine enough to pass through a 0.45 micrometer filter membrane can also contribute to total dissolved solids. Total dissolved solids comprise sodium, potassium, calcium, magnesium, chloride, sulfate, bicarbonate, carbonate, silica, organic matter, fluoride, iron, manganese, nitrate (and nitrite) and phosphate (NHMRC & NRMCC 2004a).
<b>Total filterable solids by summation</b>	Total filterable solids by summation is a water quality test which is a total of the following ions: Na (sodium), K (potassium), Ca (calcium), Mg (magnesium), Cl equivalent (chloride), alkalinity equivalent, SO <sub>4</sub> equivalent (sulfate) or S (sulfur) in grams, Fe (iron), Mn (manganese), and SiO <sub>2</sub> (silicon oxide). It is used as a more accurate measure than total dissolved solids (TDS). The higher the value, the more solids that are present and, generally, the saltier the taste.
<b>Treatment</b>	Application of techniques such as settlement, filtration and chlorination to render water suitable for specific purposes, including drinking and discharge to the environment.
<b>Turbidity</b>	The cloudiness or haziness of water caused by the presence of fine suspended matter.
<b>Wastewater</b>	Water that has been used for some purpose and would normally be treated and discarded. Wastewater usually contains significant quantities of pollutant.
<b>Water quality</b>	Water quality is the collective term for the physical, aesthetic, chemical and biological properties of water.



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