



Department of Water
Government of Western Australia



Victoria Reservoir Catchment Area Drinking Water Source Protection Plan Integrated Water Supply System

**Victoria Reservoir Catchment Area
Drinking Water Source Protection Plan
Integrated Water Supply System**

Prepared by
Water Resources Division
Department of Water

Department of Water
Water Resource Protection Series

June 2006

Acknowledgments

Contribution	Personnel	Title	Organisation
Supervision	Stephen Watson	Program Manager, Protection Planning	Department of Water*
	Jade Coleman	Senior Water Resources Planner	Department of Water*
Project Liaison Report preparation	Peter Coghlan	Senior Engineer	Water Corporation
	Palenque Blair	Engineer	Water Corporation
	Leanne Phillips	Engineer	Water Corporation
	Kathryn Chinnery	Engineering Student	Water Corporation
	Marilyn Andruszkiw	Engineering Student	Water Corporation
	Marion Burchell	Environmental Officer	Department of Water*
	Kim Hunter	Environmental Officer	Department of Water*
Drafting	Joanne Myers	Environmental Officer	Department of Water*
	Bree Atkinson	Environmental Officer	Department of Water*
	Christa Loos	Environmental Officer	Department of Water*
	Susan Taylor	Planning Information Officer	Water Corporation
	Dianne Abbott	Drafting Officer	Department of Water*

* The Department of Water was formerly the Water and Rivers Commission

Program Manager, Protection Planning
Water Quality Protection Branch
Department of Water
4th Floor, The Atrium
168 St George's Terrace
PERTH WA 6000
Telephone: (08) 6364 6500
Facsimile: (08) 6364 6520

Recommended Reference

The recommended reference for this publication is: Department of Water, 2006, *Victoria Reservoir Catchment Area Drinking Water Source Protection Plan*, Department of Water, Government of Australia, Water Resource Protection Series Report No. WRP 60.

We welcome your feedback. A feedback form can be found at the back of this publication, or online at <http://www.water.wa.gov.au>.

This document is available in alternative formats such as audio tape, computer disk, large print, Braille and other languages.

Printed on recycled stock

June, 2006

ISSN 1326-7442

Cover photograph: courtesy of the Water Corporation.

Foreword

The Department of Water (Department) has prepared this Drinking Water Source Protection Plan (DWSP) to report on the activities and risks to water quality within the Victoria Reservoir Catchment Area and to recommend management strategies to minimise the identified risks.

A safe drinking water supply is critical to the wellbeing of a community and catchment protection is necessary to help avoid, minimise or manage risks to water quality in Public Drinking Water Source Areas (PDWSA). The Department is committed to protecting these areas to ensure the continued supply of 'safe, good quality drinking water' to consumers to protect public health now and in the future.

The Australian Drinking Water Guidelines recommend a multiple barrier 'catchment to consumer' approach to protect public drinking water. The protection and management of a PDWSA is the 'first barrier', with subsequent barriers implemented at the water storage, treatment and distribution stages of a water supply system. Catchment protection includes:

- understanding the catchment, the hazards and hazardous events that can compromise drinking water quality; and
- developing and implementing preventive strategies and operational controls necessary to ensure the safest possible raw water supply (i.e. before treatment).

This Plan details the location and boundary of the drinking water catchment that provides potable water to the Integrated Water Supply System. It discusses existing use of the water source, describes the water supply system, identifies risks and recommends management approaches to maximise protection of the catchment.

The Plan should be used to guide State and local government land use planning decisions in Western Australia. This DWSP should be recognised in the Shire of Kalamunda, City of Gosnells and City of Armadale Town Planning Schemes and other local planning strategies and plans, consistent with the Western Australian Planning Commission's Statement of Planning Policy No. 2.7 *Public Drinking Water Source Policy*. Other stakeholders should use this document as a guide for protecting the quality of water in the PDWSA.

“The continued supply
of safe, good quality
drinking water”

The process involved in the preparation of a DWSP is as follows:

Stages in development of a DWSP		Comment
1	Prepare 'Drinking Water Source Protection Assessment' document	Assessment document may be prepared following catchment survey and preliminary information gathering from State and local government authority stakeholders. This stage is completed by the Department of Water or a Water Service Provider.
2	Undertake stakeholder consultation	Advice sought from key stakeholders. If a Stage 1 Assessment is available it will be used as a tool for background information and discussion.
3	Prepare Draft DWSP	Draft DWSP developed taking into account input from identified stakeholders and any additional relevant information on the catchment.
4	Release Draft DWSP for public comment	Draft DWSP released for a six week public consultation period.
5	Publish DWSP	The Plan is published after considering advice received in submissions on the Draft Plan. Recommendations to protect the drinking water catchment are provided. The Plan is available from the Department's website: http://drinkingwater.water.wa.gov.au .

Copies of Drinking Water Source Protection Assessments and Plans are available from the Department of Water website at: <http://drinkingwater.water.wa.gov.au>.

Contents

Summary	1
1. Introduction	3
1.1 Water supply system	3
1.2 Existing water source protection	3
1.3 Water resource allocation	3
2. Catchment description	6
2.1 Climate	6
2.2 Physiography and vegetation	6
2.3 Hydrology	6
3. Water quality and treatment	7
3.1 Water quality	7
3.2 Water treatment	7
4. Land use	8
4.1 Current land use	8
4.2 Private land	9
4.3 Department of Water and Water Corporation freehold land	9
5. Public Drinking Water Source Area protection	12
5.1 Proclaimed area	12
5.2 Priority classification	12
5.3 Reservoir Protection Zone	13
6. Management of water quality risks	14
6.1 Land use planning	14
6.2 Surveillance and by-law enforcement	14
6.3 Best management practices	14
6.4 Emergency response	15
6.5 Recommended protection strategies	15
Recommendations	39
References	41
Acronyms	43
Glossary	44
Appendices	46

Contents

Appendices

Appendix 1 Water Quality Results Provided by the Water Corporation	47
Appendix 2 Best Management Practice Documents for Activities in PDWSA	50

Figures

Figure 1. Victoria Reservoir Catchment Locality Plan	6
Figure 2. Victoria Reservoir Catchment Land Use and Tenure	10
Figure 3. Proposed Victoria Reservoir Catchment Area, Reservoir Protection Zone and Priority Classifications	11

Tables

Table 1. Land Use, Potential Water Quality Risks and Recommended Strategies	16
---	----

Summary

The Victoria Reservoir and its catchment are located in the Darling Range approximately 25 km east of Perth. The reservoir was constructed in 1891 on the Munday Brook, a tributary of the Canning River, and was the first permanent source of drinking water for the Perth metropolitan area. Victoria Reservoir is now an important source of public drinking water for the Integrated Water Supply System which provides scheme water to Perth, Mandurah, Pinjarra, Harvey and the Goldfields agricultural regions.

The Victoria Reservoir Catchment Area was proclaimed in 1923 under the *Metropolitan Water Supply, Sewerage and Drainage Act 1909* to ensure protection of the water source from potential contamination. An amendment to the original boundary has been agreed on to ensure it more accurately represents the physical catchment boundary.

The objective of this Drinking Water Source Protection Plan is to protect the quality of drinking water in the Victoria Reservoir Catchment Area for public supply. In part, this can be achieved through the decision making and management processes that are used to approve land use practices and activities in the catchment. The following Plan:

- identifies potential drinking water quality contamination risks from land use activities within the catchment; and
- recommends strategies to manage these potential risks whilst recognising current land use rights.

Much of the Victoria catchment is under Crown ownership with an extensive area being State forest. A Special Lease (granted under the State Agreement Act) covers part of the Crown land in the catchment and enables bauxite extraction by Alcoa of Australia. To date, no mining activity has occurred in the catchment and there are currently no plans to mine this area.

State forest is managed for the purposes defined in the Forest Management Plan 2004-2013 as conservation, recreation, timber production on a sustainable yield basis, water catchment protection and other purposes prescribed by the regulations. The Forest Management Plan is a statutory plan for State forest and recognises water catchment protection as a statutory purpose of State forest.

The Kattamorda Heritage Trail and the Munda Biddi cycle track pass through the catchment, and a golf course and shooting range are also located in the reservoir's catchment. Unauthorised recreational activities within the catchment include fishing and marroning, camping and off-road vehicle use. Rubbish and vehicle dumping are particularly prevalent within the catchment and pose a risk to water quality.

The remainder of land in the catchment is privately owned, with the majority near the southern boundary of the catchment. Land uses on these properties include several orchards, a cold store, a general shop, a fuel station and a garage. Several parcels of land are owned freehold by the Department of Water (Department) and Water Corporation.

The following strategies are recommended to protect the Victoria Reservoir drinking water source:

- all Crown land should be managed for Priority 1 source protection, except for reserve 26315, managed by Kalamunda Shire as a golf course, which should be Priority 2;
- private land should be managed for Priority 2 source protection, except for the shopping area on the corner of Pickering Brook Rd and Canning Rd, including a fuel station, automotive workshop and general store, which should be managed for Priority 3 source protection;
- the catchment, including the Reservoir Protection Zone and Priority 1 classification area, should be recognised in the relevant land planning strategies and schemes, specifically the Shire of Kalamunda, City of Gosnells and City of Armadale Town Planning Schemes; and
- best management practices for current or approved land uses in the catchment should be implemented.

1. Introduction

The Victoria Reservoir was the first permanent source of drinking water for the Perth metropolitan area and was constructed in 1891 on Munday Brook, a tributary of the Canning River, approximately 25 kilometres east of Perth. In 1990 the original dam was decommissioned, and a new dam was constructed in 1991 approximately 110 metres further upstream. The reservoir remains a strategic source of public drinking water for the Integrated Water Supply System (IWSS) which supplies water to Perth, Mandurah, Pinjarra, Harvey and the Goldfields agricultural regions.

The majority of the Victoria Reservoir catchment falls within the Shire of Kalamunda, with small sections in the Cities of Gosnells and Armadale. Refer to Figure 1 for the location of the reservoir and its catchment and Figure 2 for the administrative boundaries.

The objective of this Plan is to recommend protection strategies to ensure land uses and activities in the catchment are managed to protect the water quality of this important drinking water source. The Plan will be reviewed on a five year rotating cycle.

1.1 Water supply system

The Victoria Reservoir has a capacity of 9.5 gigalitres, and a full supply level of 202 metres Australian Height Datum (AHD). It is an important source of water for the Integrated Water Supply System (IWSS) and also supplies water locally to the foothills, which includes Kalamunda and its adjacent suburbs.

The Victoria Reservoir is currently supplemented with water from Bickley Reservoir via a pumpback scheme. The volume of water that the pumpback provides ranges between 30 percent to 40 percent of the total water taken from Victoria Reservoir used to supply the Perth metropolitan area. Since 2002 this volume has increased due to chlorinated groundwater from the metropolitan water supply system being transferred into Bickley Reservoir (thus increasing the volume of water available from Bickley).

1.2 Existing water source protection

The Victoria Reservoir Catchment Area was proclaimed in 1923 under the *Metropolitan Water Supply, Sewerage and Drainage (MWSSD) Act 1909* to ensure protection of the water source from potential contamination. Refer to Figures 2 or 3 for the existing Victoria Reservoir Catchment boundary.

The catchment area for the Bickley Reservoir has also been proclaimed under the MWSSD Act. Refer to the Bickley Reservoir Catchment Area Drinking Water Source Protection Plan for details on source protection issues in this catchment.

1.3 Water resource allocation

The Department of Water is responsible for the allocation and licensing of any water use in areas proclaimed as Surface Water or Groundwater Areas under the *Rights in Water and Irrigation (RIWI) Act 1914*. Water licence allocations are aimed at ensuring equitable use of the State's water resources between competing interests and protection of the long term security of those resources.

The Victoria Reservoir and its catchment area has been proclaimed under the *Rights in Water and Irrigation (RIWI) Act 1914* as the Victoria Reservoir Surface Water Area.

1.3.1 Current allocation licence

The Water Corporation has an allocation licence for the Victoria Reservoir, which permits the diversion of up to 4.3 gigalitres per annum from Munday Brook.

1.3.2 Future water supply

The Victoria Reservoir will continue to be used to supply water to the Integrated Water Supply System.



Victoria Reservoir

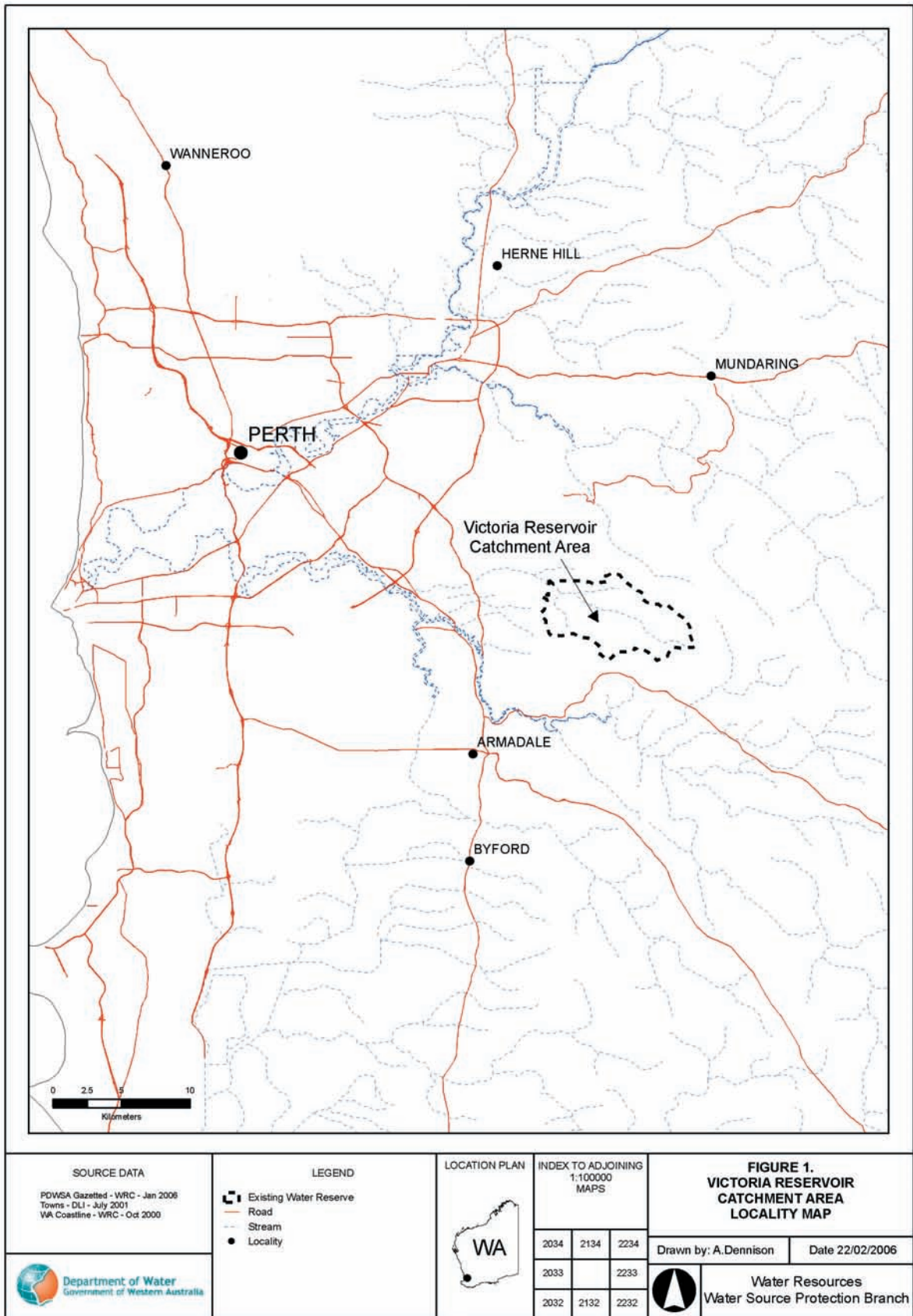


Figure 1. Victoria Reservoir Catchment Locality Plan

2. Catchment description

2.1 Climate

The Perth region has a Mediterranean climate, characterised by warm dry summers and mild wet winters. The average annual precipitation for the catchment is approximately 906 millimetres, with the majority of this rainfall falling between the months of May and September.

Over recent decades Western Australia has experienced an unprecedented and mostly unpredictable shift in its climate. In the south-west, changes in climate (as a result of the greenhouse gas effect and natural variability) have resulted in a 'drying climate', with a 10-20 percent decline in winter rainfall since 1975. As rainfall is a key driver for the environment, such changes have significant implications for our limited water resources.

2.2 Physiography and vegetation

The Victoria Reservoir catchment is located on the Darling Scarp which forms the western boundary of the Darling Range. This area forms part of the Archaean Yilgarn Block, which consists mainly of granite, gneisses, migmatite and doleritic intrusions (King and Wells, 1990).

The Murray, Yarragil and Dwellingup vegetation type complexes cover the majority of the catchment. Much of the land is open forest or woodland dominated by several Eucalyptus species. Private land exists along the southern boundary of the catchment and has been cleared for agriculture purposes and other uses.

The major valleys of the Victoria catchment are defined as the Murray soil type, which is characterised by red and yellow soils. The minor valleys consist of the Yarragil soil type, which includes sandy gravels on the slopes, and swampy floors.

The lateritic uplands are represented predominantly by the Dwellingup soil type, which forms a gently undulating landscape. This soil type consists of duricrusts on the ridges, and sands and gravels in shallow depressions. There are also some smaller areas of the Cook soil type, which includes hills mantled by laterite with some rock outcrop.

2.3 Hydrology

The catchment for Victoria Reservoir covers an area of 37 square kilometres with Munday Brook the major tributary supplying the reservoir. The long term average yield entering Victoria Reservoir via catchment inflows is 3.1 gigalitres per year (1994-2001) and includes an average input of 1.4 gigalitres via the Bickley pumpback connection.

Since 2002, Bickley Reservoir has been used to transfer chlorinated groundwater to Victoria Reservoir. This has increased the total volume of water supplied via the pumpback from Bickley to between 25 percent and 50 percent of the total water volume held in the Victoria Reservoir.

3. Water quality and treatment

3.1 Water quality

A wide range of chemical, physical and microbiological properties can affect the health and aesthetic quality of drinking water. The Water Corporation monitors the raw (source) water quality from Victoria Reservoir consistent with the Australian Drinking Water Guidelines (ADWG). For details of the raw water quality analyses undertaken by the Water Corporation (between 1999 and 2004) refer to Appendix 1.

The Water Corporation undertake catchment sampling according to their operational guidelines. As part of the catchment water quality sampling program, risks are identified and sampling carried out downstream of any potential contamination source as well as sampling on each major feeder stream and the reservoir itself. Point and non-point source microbiological risks have been identified in the Victoria Catchment Management Strategy and a recommended sampling program for raw water, the reservoir and catchment streams has been defined.

3.2 Water treatment

The water abstracted from the Victoria Reservoir is disinfected (chlorinated), and fluoridated before supplying the Integrated Water Supply System (IWSS). Chlorination is the primary barrier used against unwanted bacteriological activity to ensure good quality public drinking water. Under high turbidity water conditions chlorination can be ineffective in treating raw water for microbiological contamination (NHMRC and ARMCANZ, 1996). As such the Water Corporation monitors turbidity concentrations in raw water supplies.

Pumpback from Bickley to the Victoria Reservoir only operates during the winter months when the Victoria Reservoir is 'offline'. In order to facilitate mixing and dilution of the water transferred from Bickley, Victoria remains offline for approximately one month after the cessation of pumpback activities.

Although reservoir storage and disinfection by chlorination generally removes contamination to provide safe drinking water, treatment processes alone cannot and should not be relied upon. Where possible, contamination should be prevented or reduced through appropriate land use or activity controls in the catchment area. This approach is endorsed by the Australian Drinking Water Guidelines (NHMRC and ARMCANZ, 1996) and reflects a 'catchment to consumer' multiple barrier approach for the provision of safe drinking water to consumers.

Western Australia has adopted this approach in the management of its public drinking water catchment and it is also recommended for the protection of private water supplies.

4. Land use

4.1 Current land use

Current land use in the Victoria Reservoir catchment includes:

- land and forest management on Crown land;
- recreation on Crown land;
- rural and commercial land use on private land; and
- land management on Department of Water and Water Corporation freehold land.

Land use and tenure in the catchment are shown in Figure 2. The source protection area falls across the administrative boundaries of the Shire of Kalamunda, City of Gosnells and City of Armadale.

Native Title claims (Reference: *WAG0142_98*) exist over the land within the Victoria Reservoir Catchment Area. The claimants are represented by the South West Aboriginal Land and Sea Council.

4.1.1 Crown land - land and forest management

Approximately 90 percent of the Victoria catchment is under Crown ownership. An extensive area of the catchment is State forest (Number 54) which has been vested with the Conservation Commission of Western Australia and is managed by the Department of Conservation and Land Management (CALM).

State forest within the catchment has recently (2004) been reserved as national park following the *Reserves (National Parks and Conservation Parks) Bill 2004*. State forest is managed for the purposes defined in the *Forest Management Plan 2004-2013* as conservation, recreation, timber production on a sustainable yield basis, water catchment protection and other purposes prescribed by the regulations. For further information on forest land management, refer to the *Forest Management Plan 2004-2013* (Conservation Commission of Western Australia, 2004).

In addition to State forest on Crown land, Reserve 21172 (vested with Water Corporation) consists of remnant vegetation and is used for the purpose of water quality protection of the Munday Brook. There is a golf course on Reserve 26315, vested with the Shire of Kalamunda.

A Special Lease, granted under the State Agreement Act to Alcoa of Australia (Alcoa) in 1961, covers part of the Crown land area. This lease permits Alcoa to extract bauxite from the area, but includes a responsibility to ensure the environmental value of the area is protected and mine sites are rehabilitated. As yet, no mining activity has occurred in the catchment, and there are currently no plans to mine in the immediate future.

Management of State forest by CALM is in accordance with the purpose of State forest and includes fire management (for biodiversity conservation and the protection of assets) and the control of feral animals (fox baiting and feral pig trapping). All feral animal control activities on land managed by CALM must be coordinated by CALM. In addition to State forest, CALM also has management responsibilities for unallocated Crown land. Such responsibilities include the promotion of conservation of biodiversity, fire prevention, weed and animal control, harvesting of flora and forest produce and management of recreation.

Licences for commercial firewood collection are issued by CALM, with collection from State forest facilitated through the commercial harvesting of the forest by the Forest Products Commission. The collection of firewood by the public is not permitted within nature reserves, national parks or conservation parks except in designated firewood areas in State forest and timber reserves. Apiaries (nine sites), wildflower picking and seed collection also occur in the State forest and are licensed by CALM. The catchment and reservoir are also occasionally used for research projects.

Management of forest on other tenures includes softwood timber production on a small plantation in the catchment.

4.1.2 Crown land - recreation

Given the relatively unrestricted access to the Victoria catchment, numerous authorised and unauthorised recreational activities occur there.

Authorised activities include the Kattamorda Heritage Trail, an established walk trail managed by CALM that passes through the catchment to the north of the reservoir. The Munda Biddi long distance mountain bike trail, opened in 2004, also passes through the back of the Victoria catchment along Carinyah Road. It is likely that this track will increase visitor numbers in the catchment but, providing visitors keep to the designated trail, should have minimal impact.

A golf course and a shooting range are located inside the catchment. The golf course is affiliated with the Pickering Brook Sports Club that lies on the catchment boundary. Some irrigation of the golf course occurs from bore water sourced on site, but the fairways are not watered. The shooting range in State forest east of Canning Road in the north of Victoria catchment is operated by a small rifle club that uses the area on weekends.

Unauthorised recreational activities include fishing and marroning, camping and off-road vehicle use. Rubbish and vehicle dumping are particularly prevalent in the Victoria catchment.

4.2 Private land

Private land comprises approximately 260 ha of the total catchment area (of 3686 ha) and can be found mostly near the southern boundary. Land use in this area is primarily agricultural (orchards). The remaining private land in the catchment is characterised by smaller properties close to the northern boundary and land uses include orchards, a general store, a hairdresser, a fuel station (closed) and automotive workshop, and cold store. All commercial land uses occur in the north of the catchment (refer to Figure 2).

4.3 Department of Water and Water Corporation freehold land

The Department of Water and the Water Corporation have freehold ownership of several properties in the catchment consisting of small cleared or partly revegetated blocks. The Water Corporation has vested responsibility for their management.

Land management by the Water Corporation includes fire management such as prescribed burning and maintenance of firebreaks. Prescribed burning is done in conjunction with the relevant shire authorities.

These freehold properties are frequented for the purposes of illegal recreation, often resulting in the dumping of stolen cars and rubbish.

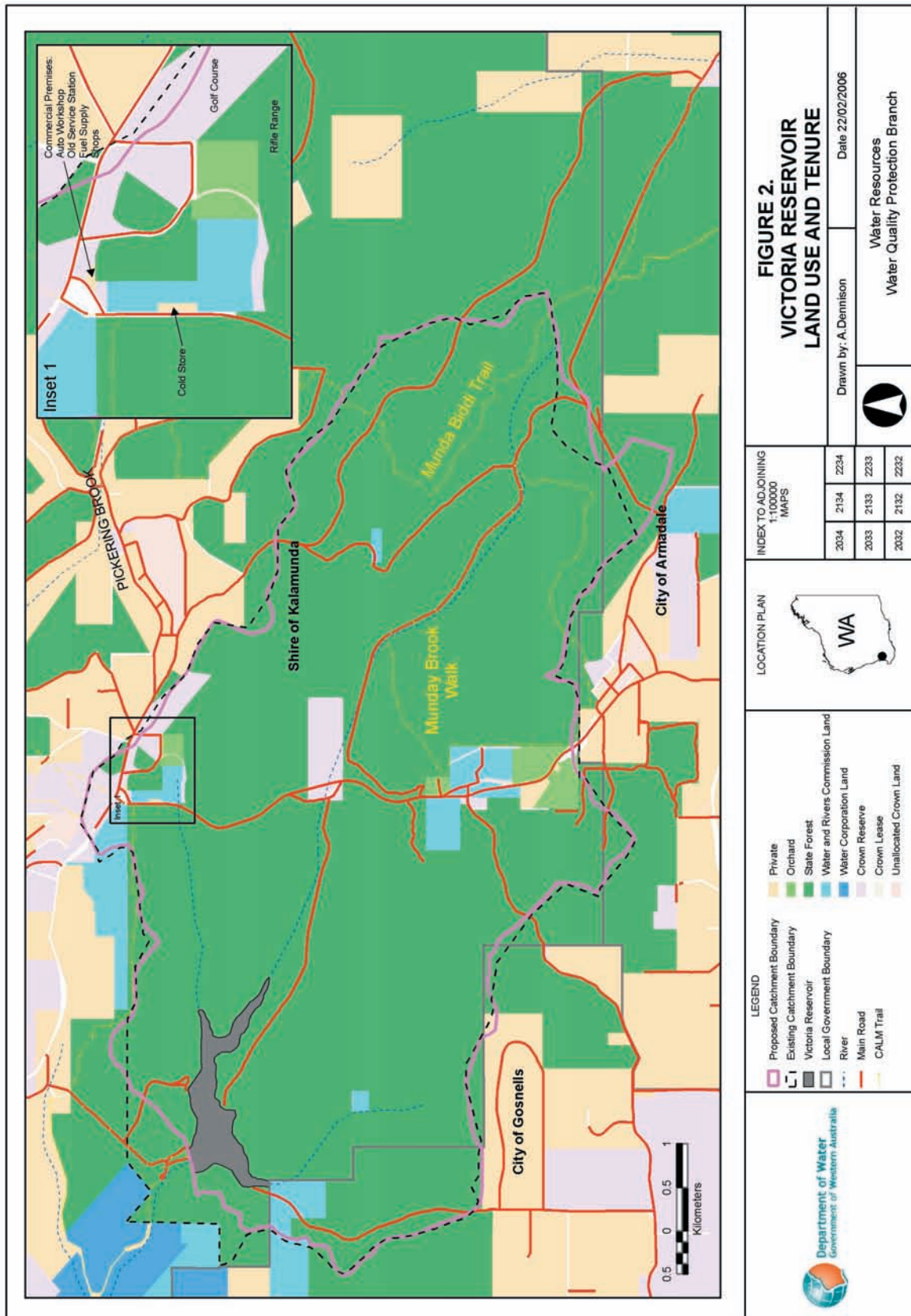


Figure 2. Victoria Reservoir catchment land use and tenure

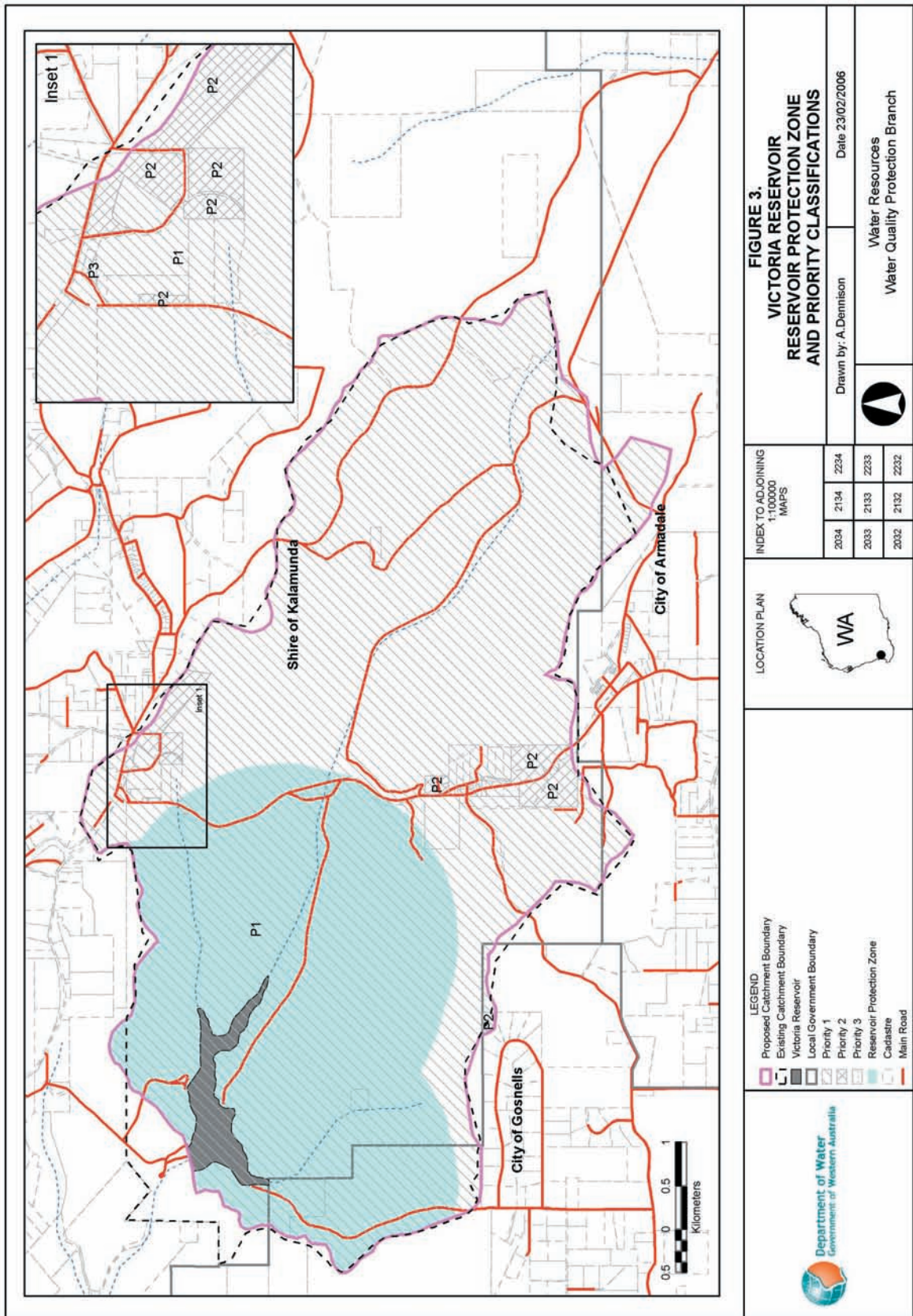


Figure 3. Victoria Reservoir catchment area, Reservoir Protection Zone and Priority Classifications

5. Public Drinking Water Source Area protection

The protection of Public Drinking Water Source Areas (PDWSAs) by the Department of Water is consistent with government policy and involves three key elements:

- the proclamation of the PDWSA;
- the determination of 'priority classification areas' for land within the PDWSA; and
- the establishment of a Reservoir Protection Zone within the PDWSA.

The preparation of this Drinking Water Source Protection Plan forms part of the 'multiple barrier' approach for the protection of public drinking water sources from potential contamination. The strategies used to protect PDWSAs in this Plan recognise the rights of existing and approved land uses and activities.

5.1 Proclaimed area

Areas 'proclaimed' for drinking water purposes include Underground Water Pollution Control Areas (UWPCA), Water Reserves and Catchment Areas declared under the *Metropolitan Water Supply, Sewerage and Drainage Act 1909* or the *Country Areas Water Supply Act 1947*.

The Victoria Reservoir Catchment Area was proclaimed in 1923 under the *Metropolitan Water Supply, Sewerage and Drainage Act*. An amendment to the original boundary has been adopted so that it will more accurately represent the physical catchment boundary.

The proposed Victoria Reservoir Catchment Area is shown in Figures 2 and 3.

5.2 Priority classification

Land within PDWSAs is allocated one of three priority classifications (1, 2 or 3). The classification looks to prioritise areas for the protection of water quality and has been defined using present land use information, existing or approved land zoning, ownership, the importance of the water source, and the vulnerability of the water body. Each priority classification allows different levels of activity according to the degree of risk to the water resource. Additional constraints may also apply in zones closest to the point where drinking water is harvested or stored. These areas are known as Wellhead Protection Zones (WPZ) or Reservoir Protection Zones (RPZ).

Further details of the priority classifications and the detail of land use compatibility with each priority classification are provided on the Department's Internet site at www.drinkingwater.water.wa.gov.au.

The majority of the land in the Victoria catchment is Crown land. Where possible Crown land should be managed for Priority 1 (P1) source protection. The objective of a P1 classification is risk avoidance for the protection of water quality. A P1 source protection classification is appropriate for Crown land as:

- the Victoria Reservoir Catchment Area is an important source of public drinking water for the Integrated Water Supply System, and should be afforded the highest level of protection;

- the land is State forest or owned freehold by State government agencies; and
- most existing land use practices are compatible with P1 source protection, or can be managed for P1 source protection with the use of best management practices.

The golf course (located on Crown land Reserve 26315) on the northern boundary of the catchment should be managed for Priority 2 source protection to minimise any potential water quality impacts (see Table 1). The objective of Priority 2 classification is to protect water quality according to the principle of risk minimisation.

Private land in the Victoria catchment should largely be managed for Priority 2 (P2) source protection. The cold store on Canning Road should also be managed for P2 source protection due to the proximity of the property to streams and its drainage from the property down the road reserve. A P2 source protection classification is appropriate for these areas as:

- the Victoria Reservoir is a strategic source of public drinking water for the Integrated Water Supply System; and
- existing land use practices are compatible with P2 source protection with implementation of best management practices.

The shopping area on the corner of Pickering Brook Road and Canning Road which includes a fuel station, an automotive workshop and general store, should be managed for Priority 3 (P3) source protection. Discussions with the owner should continue to investigate the option of permanent removal of the fuel station structures as the underground fuel tanks pose an unacceptable risk to water quality (see Table 1). Should dismantling of the structures not be deemed appropriate regular environmental assessments of the site should be conducted.

5.3 Reservoir Protection Zone

To protect the reservoir from immediate risks to water contamination, a prohibited zone (also known as a Reservoir Protection Zone (RPZ)) extends for 2 km from the top water level of the reservoir and includes the reservoir itself (refer to Figure 3). Within these zones, by-laws prohibit, restrict and regulate land use and human activities to prevent water source contamination. For further details on RPZs refer to the Department's Internet site at <http://drinkingwater.water.wa.gov.au>.

There are no trails or private land within the RPZ for the Victoria catchment, with only State forest or freehold land falling within the 2 km RPZ area.

6. Management of water quality risks

6.1 Land use planning

It is recognised under the *State Planning Strategy* (Western Australian Planning Commission, 1997) that the establishment of appropriate protection mechanisms in statutory land use planning processes is essential to secure the long term protection of water sources.

It is therefore recommended that the Metropolitan Region Scheme and the Town Planning Schemes for the Shire of Kalamunda, City of Gosnells and City of Armadale recognise priority classification areas and protection zones assigned to land in the Victoria Reservoir Catchment Area. This is consistent with the Western Australian Planning Commission's Statement of Planning Policy 2.7 *Public Drinking Water Source Policy* (June 2003).

The Department of Water provides advice on the compatibility of land uses within the proposed priority classification areas based on the guidance document *Land Use Compatibility in Public Drinking Water Source Areas* (see www.drinkingwater.water.wa.gov.au/wqpn). Development and work proposals in the catchment that are inconsistent with the land use table should be referred to the Department's Swan Goldfields office for assessment and recommendation.

6.2 Surveillance and by-law enforcement

The Department of Water has delegated the responsibility for surveillance and associated by-law enforcement in the Victoria Reservoir catchment to the Water Corporation who report annually to the Department. As the catchment area has been proclaimed under the MWSSD Act, the by-laws of this Act can be used to control potentially contaminating activities within the catchment.

By-law enforcement, through on-ground surveillance of land uses and activities, is a critical mechanism in protecting the quality of drinking water sources. Water Corporation Ranger communication with visitors to the catchment also assists in increasing public awareness of the need to protect drinking water quality.

The use of signs and other informative material is also an important component of water quality protection for those who visit the catchment and for landowners in the catchment.

6.3 Best management practices

To help protect water quality in the catchment, best management practices for land use activities are encouraged. These are often in the form of industry codes of practice and environmental guidelines. Guidance documents are usually developed in consultation with industry groups, producers and State government agencies.

Best management practices can be developed for an individual enterprise or have a local or regional focus and must consider the full range of economic, social and environmental issues associated with land, water and vegetation use. Development of best management practices must also take into consideration the needs and concerns of users, consumers and the wider community (ARMCANZ & ANZECC, 1996).

The potential risks to water quality from existing land uses can be reduced by the implementation of best management practices. For example, fencing to control stock access to watercourses, retention of vegetation along streamlines (riparian zones), appropriate pesticide, herbicide and fertiliser application practices (as detailed in Statewide Policy No.2 *Pesticide Use in Public Drinking Water Source Areas* (WRC, 2000)) and septic tank management. The implementation of best management practices for land use activities in the catchment is encouraged to protect water quality.

Similarly, the potential risks to water quality associated with forestry activities can be managed by the adoption of best management practices such as appropriate road construction and maintenance, use of sumps or drains for sediment control, and appropriate retention of buffer zones along watercourses. Refer to the *Manual of Management Guidelines for Timber Harvesting in Western Australia* (CALM, 1999a) and the Department's Water Quality Protection Note *Buffers to Sensitive Water Resources*.

The implementation of best management practices for land use activities in the catchment is encouraged and expected to assist in protecting water quality.

A reference list of best management practice documents for some of the catchment activities in Victoria Reservoir is provided in Appendix 2.

6.4 Emergency response

Discharge of chemicals during unforeseen incidents and use of chemicals during emergency response can result in the contamination of water sources. The Shire of Kalamunda, City of Armadale and the City of Gosnells Local Emergency Management Advisory Committees through the Cannington and Midland Emergency Management Districts should be familiar with the location and purpose of the Victoria Reservoir Catchment Area. A locality plan should be provided to the Fire and Rescue Services headquarters for the HAZMAT Emergency Advisory Team. The Water Corporation should also have an advisory role in any HAZMAT incident in the catchment area.

Personnel who deal with WESTPLAN - HAZMAT incidents within the area should be given ready access to a locality map of the Victoria Reservoir Catchment Area. These personnel should receive training on the potential impacts of spills on the surface water resources.

6.5 Recommended protection strategies

Table 1 identifies the potential water quality risks associated with existing land uses in the Victoria catchment, and recommends protection strategies to manage these risks.

The potential water quality risks were identified and resulting management priorities designated using a risk assessment process. Strategies have been developed in line with the Australian Drinking Water Guidelines (NHMRC and ARMCANZ, 1996).

The recommended protection strategies balance the need to protect water quality now and in the long term with the rights of landholders to continue to utilise their land for approved use.

Table 1. Land Use, Potential Water Quality Risks and Recommended Strategies

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
Private Land				
General farming <ul style="list-style-type: none"> Orchards Hobby farms Residences Apiaries 	The potential risks to water quality associated with these land uses include: <ul style="list-style-type: none"> pathogen and nutrient contamination from septic systems and domestic animals; nutrient and pesticide contamination from fertiliser and pesticide use and storage; hydrocarbon contamination through fuel spills from fuel storage and refuelling, mechanical servicing and waste oil disposal; increased turbidity as a result of clearing and poor land management practices; increased stream salinity from water balance changes as a result of clearing; water quality degradation if there is no buffer between orchards and stream zones. 	Medium Medium Low Medium Low Medium	It is recognised that use of private land for agriculture is an existing approved land use and is essential for the livelihood of residents. It is essential that best management practices be adopted to ensure the risks associated with these activities are managed. Best management guidelines are specified in the Water Quality Protection Note on Orchards in Sensitive Environments. Private land in the catchment is currently zoned for rural activities under the Shire of Kalamunda Town Planning Scheme. The zonings include restrictions on subdivision of property. Intensification of the land use is undesirable; this imposes constraints on landowners.	Existing land uses are acceptable with best management practices. <ul style="list-style-type: none"> Encourage landowners to adopt best management practices particularly with regards to fertiliser and pesticide application and stream buffer zones. Provide information and advice to landowners and local government agencies on best management practices for domestic on-site wastewater treatment systems (Health Department of WA, 1998 and 1999), including the regular pumping out of septic systems. Ensure the water quality protection objectives of the priority classifications P1, P2 and P3 are recognised in the Town Planning Scheme of relevant local government authorities. Relevant local government authorities to refer development proposals that are likely to impact on water quality to the Department of Water for advice and recommendation which is consistent with the Department's Land Use Compatibility Table (LUCT) and Statement of Planning Policy (SPP) 2.7. Assess and provide guidance on development proposals within the catchment area to ensure that water quality protection requirements are addressed. Oppose intensification of land use and encourage a reduction in land use intensity through planning approval process.

Table 1. continued

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
<p>Commercial activities</p> <ul style="list-style-type: none"> • General store • Hairdresser • Fuel station (closed) • Auto workshop • Cold store 	<p>The potential risks associated include:</p> <ul style="list-style-type: none"> • hydrocarbon contamination through fuel spills from fuel storage and refuelling, leaks from fuel storage tanks, mechanical servicing and waste oil disposal, leaks from parked vehicles; • leaks or spillage of hazardous chemicals stored for the cold store; and • pathogen contamination from septic systems and farm supplies. 	<p>Medium</p> <p>Medium/high</p> <p>Medium</p>	<p>The risks associated with the fuel station, workshop and cold store can be managed through appropriate storage and containment of fuel tanks, chemicals and products and appropriate management of runoff. Management guidelines are specified in the Water Quality Protection Notes on <i>Above Ground Chemical Storage Tanks in Public Drinking Water Supply Areas, Service Stations and Mechanical Servicing and Workshops</i>. The fuel station has closed to the public, and discussions with the owner regarding removal of underground storage tanks should continue and any leaks addressed according to Department of Environment guidelines.</p> <p>The other commercial properties (general store and hairdresser) are more distant from the reservoir and its tributaries. These activities store and transport smaller quantities of hazardous chemicals, making the risk of significant pollution relatively small. Implementation of BMPs should be sufficient to prevent pollution from these businesses.</p>	<p><i>Existing activities are acceptable with best management practices.</i></p> <ul style="list-style-type: none"> • Encourage landowners to adopt best management practices particularly with regards to stormwater management and chemical and product storage. • Provide information and advice to landowners on best management practices for domestic on-site wastewater treatment systems (Health Department of WA, 1998 and 1999), including the regular pumping out of septic systems. • Ensure the water quality protection objectives of the Priority 1, 2 and 3 classifications are recognised in the Town Planning Schemes of relevant local government authorities. • Assess and provide guidance on development proposals within the catchment area to ensure that water quality protection requirements are addressed. • Oppose intensification of land use and encourage a reduction in land use intensity through planning approval process. • Conduct a risk assessment of the closed fuel station and through liaison with the owner investigate the possibility of removing the underground tanks and remediating any leakage or contaminated soil.

Table 1. continued

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
Land and Forest Management				
Plantation timber harvesting	<p>The potential risks to water quality include:</p> <ul style="list-style-type: none"> turbidity due to log handling and establishment practices, and use and upgrading of unsealed roads and tracks, and runoff from cleared areas adjacent to major streamlines; fuel spills from vehicles and machinery during harvesting and upgrading of roads; chemical contamination from fertiliser and pesticide application during softwood plantation establishment; and pathogens due to human presence. 	<p>There are about 7 hectares of softwood plantation in the catchment, of which about half is adjacent to a stream about 2.2 kilometres upstream of the reservoir high water mark, with no significant buffer of native vegetation. The remainder is split between two areas of 1-2 hectares each. The plantations currently consist of established, mature trees. The width and vegetation quality of buffer zones need to be reviewed, with the aim of restoring a natural vegetation buffer adjacent to watercourses.</p> <p>The impact of softwood harvesting on water quality can be minimised through proper management, including maintenance of roads, retention of vegetation buffers along watercourses, and appropriate fertiliser and pesticide use.</p> <p>Management guidelines are specified in the Draft Water Quality Protection Note on <i>Buffers in Sensitive Waters</i>.</p>	<p>Acceptable activity with best management practices.</p> <ul style="list-style-type: none"> Ensure plantation harvesting occurs in accordance with the <i>Manual of Management Guidelines for Timber Harvesting in WA</i> (CALM, 1999a) and the <i>Code of Practice for Timber Plantations in WA</i> (FPC, 2003), including compliance with standards for road construction, maintenance and rehabilitation, use of sumps or drains for sediment control, appropriate retention of buffer zones along watercourses, fuel storage and handling, fertiliser use and pesticide use. Establish protocols for joint field inspections with relevant agencies prior to harvesting operations. Continue to inspect water quality protection measures on site. Ensure contract specifications recognise water quality protection objectives including use of chemical toilets during periods of intensive activity on the site. Pesticide used in accordance with Statewide Policy No. 2 <i>Pesticide Use in Public Drinking Water Source Areas</i> (WRC, 2001) and PSC 88 (Health Department of WA, 1993). Update timber plantation and harvesting manuals in accordance with Forest Products Commission (FPC), CALM, Water Corporation, Department of Environment and Department of Water requirements. Ensure that appropriate streams are monitored before and after harvesting and chemical application to identify any impact. 	<p>Medium</p> <p>Low</p> <p>Medium</p> <p>Low</p>

Table 1. continued

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
<p>Native forest timber harvesting</p> <p><i>Will only affect a small part of the native forest (~30 hectares) located at the back of the catchment.</i></p>	<p>The risks associated with firewood collection include:</p> <ul style="list-style-type: none"> turbidity due to log handling practices, and use of unsealed roads and tracks; fuel spills from vehicles and machinery; pesticides from harvesting practices; and pathogens due to human presence including from increased public access with road upgrading. 	<p>Low</p> <p>Low</p> <p>Low</p> <p>Low</p>	<p>Most State forest in Victoria catchment will become national park, thus no further native forest timber harvesting will occur in these areas.</p> <p>The impact of native forest harvesting on water quality can be minimised through proper management, including maintenance of roads, retention of vegetation buffers along watercourses, and appropriate fertiliser and pesticide use.</p> <p>Timber harvesting within 200 metres of the high water level of the reservoir or major feeder streams greatly increases the risk of contamination of the water source, as there is not a large enough buffer to protect the source.</p> <p>Management guidelines are specified in the Draft Water Quality Protection Note on <i>Buffers in Sensitive Waters</i>.</p> <p>The timber harvesting guidelines indicate that the Water Corporation (WC) need to be notified if harvesting is going to occur within 500 metres of the high water level of water reservoirs. Harvesting could occur within the Reservoir Protection Zone (RPZ).</p> <p>Forest Products Commission (FPC) and CALM forestry operations are governed by the Forest Management Plan 2004 to 2013.</p>	<p><i>Acceptable activity with conditions.</i></p> <ul style="list-style-type: none"> Continue to review harvesting plans during the planning phase to ensure water quality protection objectives are included. Continue to inspect water quality protection measures on site. Where possible avoid logging in the RPZ and see the Department's Water Quality Note on <i>Buffers to Sensitive Water Resources</i>. It is however acknowledged that harvesting operations are currently being phased out. Require chemical toilets to be provided for contractors working within the RPZ, and no closer than 100 m to reservoir or tributaries. Timber harvesting occurs in accordance with the <i>Contractors' Timber Harvesting Manual – South West Native Forests (FPC, 2003)</i> and the <i>Code of Practice for Timber Harvesting in Western Australia (CALM, 1999b)</i>. Update timber harvesting manuals and codes in accordance with FPC, CALM, Water Corporation, Department of Environment and Department of Water requirements. Continue to close and rehabilitate tracks that are not required for forest operations and management or transport thoroughfare. Recommend that when the timber harvesting guidelines are updated, WC notification and request for advice on harvesting is required within the whole RPZ and adjacent to major feeder streams.

Table 1. continued

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
Fire suppression <ul style="list-style-type: none"> • Emergency firebreaks • Water points 	The potential risks to water quality include: <ul style="list-style-type: none"> • turbidity; • carbon and nutrient contamination from airborne and eroded ash; • an increase in turbidity from the use of unsealed roads and tracks; • fuel spills from vehicles and machinery; and • pathogens from direct contact of firefighters with water bodies. 	High Low Low Low Low	Extensive burning from wild fires can be caused either naturally or following irresponsible human access. Fuel reduction burning tends to decrease the chance of intense wild fire and yet may be the source of wild fire. Firebreaks are cut in the event of an emergency and are not cut on a routine basis. Biodiversity considerations will also need to be factored in.	Acceptable activity with best management practices. <ul style="list-style-type: none"> • Wild fire causes a critical situation that requires quick decisions. In order for water quality considerations to be sufficiently addressed, a Water Corporation staff member should attend all fires in catchment areas. • Where location, extent or intensity of a fire suggests the need, inspect sites following fire to assess need for turbidity mitigation works, and conduct these at the combined expense of the Water Corporation and the Department of Conservation and Land Management. • Ensure sites that need permanent protection from wild fire have adequate firebreaks and/or low-vegetation buffer zones to prevent the need for extensive earthworks or clearing at short notice during a fire. • Ensure that any planned firebreaks required on an ongoing basis minimise risks to soil disturbance.

Table 1. continued

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
Vehicle roads and tracks	<p>The risks associated with the use of roads and tracks include:</p> <ul style="list-style-type: none"> turbidity from erosion of unsealed roads and tracks; fuel and chemical spills from vehicles and machinery; pathogen contamination from public access to the water body; and provision of access leading to illegal activities and rubbish dumping in the catchment. 	<p>Medium</p> <p>Medium</p> <p>Medium</p> <p>Medium</p>	<p>Some roads and tracks are necessary for timber harvesting, fire management and general land and forest management. However, it is essential they are well maintained to minimise the risk of erosion, and hence the impact on water quality.</p> <p>All roads and tracks in the State forest are open to the public, and control of access is a major issue in the catchment. Tracks provide direct access to the dam and catchment. Public access to the water body increases all associated risks of rubbish dumping and pathogen contamination.</p>	<p><i>Acceptable activity with conditions.</i></p> <ul style="list-style-type: none"> Adherence to the Department's Water Quality Protection Note Roads in Sensitive Environments. Review the road network to identify roads not essential for forest management or transport thoroughfare. Rehabilitate tracks that are not required for forest management or transport thoroughfare. Set a definition of 'Public Road' and educate the public on definition and implication for by-law enforcement. Undertake road construction and maintenance to avoid water source contamination risks. Ensure road upgrades follow alignments and incorporate measures to avoid or minimise water source contamination risks. Restrict development of new roads through the catchment. Use signs along roads to inform that they are in a public drinking water supply catchment, and display the emergency contact number in the event of a spill. The development of tracks and roads within the RPZ is inconsistent with existing by-laws.

Table 1. continued

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
<p>Feral animals and their control</p> <ul style="list-style-type: none"> Feral pigs Foxes <p><i>(Rabbits and cats are also present but are not perceived to pose a significant water quality problem)</i></p>	<p>The major risk to water quality associated with feral animals in the catchment is pathogen contamination. Feral pigs can increase turbidity levels through wallowing.</p> <p>Feral pig control is carried out by landowners (one of which is CALM) and involves additional risks associated with pathogen contamination from feral animal carcasses, and from people and dogs remaining in the catchment for extended periods, and associated camping.</p> <p>Illegal introduction of pigs and associated diseases by hunters is known to have occurred and increases all risks associated with the animals.</p> <p>Fox control occurs through baiting, and involves a risk of pathogen contamination from animal carcasses and uneaten baits.</p>	<p>Medium/High</p> <p>Medium</p> <p>Medium</p> <p>Low</p>	<p>Under <i>Metropolitan Water Supply, Sewerage and Drainage Act</i> by-laws shooting, trapping or hunting of game is prohibited in catchment areas, as is the presence of dogs. Permission must be sought from the Department of Water prior to carrying out these activities.</p> <p>Feral animal control reduces the risks associated with these animals, but may introduce additional risks to water quality if not properly managed. It is essential that feral pig control, in particular, be well managed and organised in order to minimise the potential impacts on water quality.</p> <p>Feral pig control is carried out by landholders and involves additional risks associated with pathogen contamination from feral animal carcasses, and from people and dogs in the catchment. The Water Corporation currently undertakes some feral pig control in the catchment, using the 'trap-and-shoot' method. This method reduces the risks to water quality as animal carcasses can be removed from the catchment.</p> <p>The bait used for fox control contains 1080 (sodium monofluoroacetate), which is a naturally occurring chemical and not believed to pose a risk to water quality. Protocol followed by CALM is to ensure baits are not placed within 100 metres of watercourses or reservoirs.</p>	<p><i>Acceptable activity with conditions.</i></p> <ul style="list-style-type: none"> Ensure feral pig control is performed by the 'trap-and-shoot' method only, without the use of dogs. Ensure all feral animal control occurs as part of an integrated management program. Refer to inter-agency guidelines on the managed control of feral pigs that address water quality protection requirements, such as the presence of hunters in the RPZ, the presence of dogs in the catchment and the burying of feral animal carcasses. Baits used for fox control are not placed within 100 metres of the full supply level of a reservoir and where possible not within 100 metres of any watercourse.

Table 1. continued

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
Private resource harvesting <ul style="list-style-type: none"> • Apiaries • Wildflower picking • Seed collection 	The potential risk to water quality from these activities includes: <ul style="list-style-type: none"> • pathogen contamination through the presence of people near the reservoir and tributaries, and associated camping; and • increased turbidity due to use of unsealed roads. 	Low Low	The primary concern is the potential for people to be in close proximity to the reservoir or tributaries. The permit conditions imposed by CALM for apiarists cater for water quality protection in public drinking water source areas. CALM and Alcoa collect seeds for rehabilitation. CALM also licenses a number of private seed collectors and wildflower pickers. The low numbers of people involved, together with management controls, reduces the risk associated with these activities. The potential risks to water quality are increased when activity is within an RPZ or near a reservoir or feeder streams.	<i>Acceptable activity with conditions.</i> <ul style="list-style-type: none"> • Ensure water required at apiary sites is not sourced from the reservoir, but trucked in as per licence conditions. • Ensure approval conditions for apiarists, wildflower picking and seed collection licences require adherence to water quality protection objectives, including exclusion from RPZ and prohibiting camping within the catchment. • Inspect water quality protection measures on site. • On expiry of apiary permit, sites within RPZ are relocated to outside RPZ.
Firewood collection	The risks associated with firewood collection include <ul style="list-style-type: none"> • pathogen contamination through the presence of people near watercourses; • rubbish dumping as a consequence of public firewood collection; and • turbidity from use of unsealed roads and damage to vegetation during off-road driving. 	Medium Medium Low	The primary concern is the potential for people to be close to the reservoir or tributaries during public firewood collection. The collection of firewood is managed by CALM through a permit system. Rubbish dumping is often associated with public firewood collection points. Domestic animals often accompany people during firewood collection.	<i>Acceptable activity with conditions.</i> <ul style="list-style-type: none"> • Ensure regional plans for public firewood collection areas give consideration to water quality protection objectives. • Promote firewood collection sites outside the catchment. • Where public firewood areas are within the catchment, establish designated public firewood areas outside the RPZ, away from the reservoir and tributaries, and restrict activity to areas at the edge of the catchment. • Ensure the public firewood areas are regularly patrolled and rubbish dumped is removed. • Use signs and brochures to promote water catchment awareness.

Table 1. continued

Activity	Potential Water Quality Risks		Management Priority	Consideration for Management	Recommended Protection Strategy
	Hazard				
Bauxite mining <i>Does not currently occur in Victoria</i>	The potential water quality risks associated with bauxite mining are: <ul style="list-style-type: none"> turbidity from erosion of cleared and excavated land, and the use of unsealed roads and tracks; hydrocarbon contamination through fuel spills from vehicles and machinery; and pathogen contamination from increased human activity in the catchment. 	Low Low Low	Through the Department of Industry and Resources, Alcoa of Australia holds a Special Mining Lease under the State Agreement Act, which covers part of the catchment. However mining has not occurred to date, and there are currently no plans to mine this area. A multi-agency group, the Mining and Management Program Liaison Group (MMPLG), oversees the implementation of the State Agreement Act. This includes reviewing of Alcoa's five year mine plan and enforcing environmental (including water quality protection) conditions where appropriate. The Department of Water and the Water Corporation are represented on this group.	<p><i>Acceptable if operated in compliance with conditions imposed by MMPLG.</i></p> <ul style="list-style-type: none"> Ensure any conditions imposed by the MMPLG specifically pertaining to water quality protection are adhered to. 	
<i>Research projects</i>	The use of the catchment and reservoir for research projects involves a potential risk of pathogen contamination from people remaining in the catchment for extended periods, particularly close to or on the reservoir.	Low	The risk associated with this activity is minimal, due to the low numbers of people involved, management controls and the ease of education prior to the activity occurring. Frequently supervised by Water Corporation staff.	<p><i>Acceptable activity with conditions.</i></p> <ul style="list-style-type: none"> Ensure education on water quality protection requirements is undertaken prior to activity. Apply a condition of approval that requires adherence to water quality objectives. Seek approval from the Department of Water if research activities are within the RPZ. 	

Table 1. continued

Activity	Potential Water Quality Risks		Management Priority	Consideration for Management	Recommended Protection Strategy
	Hazard				
Gravel pit	<p>The potential risks associated with the use and maintenance of gravel pits, which are used for sourcing material for road maintenance, include:</p> <ul style="list-style-type: none"> increased turbidity from gravel extraction processes associated with poor overburden management and/or drainage control and recreational use; fuel and chemical spills from vehicles and machinery; pathogens from human presence, particularly as gravel pits often attract illegal recreation by some members of the public; and rubbish dumping often in the form of car bodies associated with the illegal recreation. 	<p>Gravel pits are focal points for illegal and sometimes destructive recreation activities usually involving vehicles. Recreational activities may be responsible for failure of rehabilitation in gravel pits.</p> <p>The gravel pit to the west of Canning Road in the southern part of the catchment is a particular focus for illegal recreation activities and blocking the access road has been ineffective.</p> <p>Gravel pits used for road maintenance require effective site management to reduce risks to water quality. New pits established by CALM are rehabilitated after use.</p> <p>Management guidelines are specified in the Water Quality Protection Note <i>Extractive Industries within PDWSAs</i>.</p>	<p>Acceptable activity with best management practices.</p> <ul style="list-style-type: none"> Pits should be rehabilitated immediately after decommissioning. Ensure gravel pits are outside the RPZ. Inspect water quality measures on site. Ensure contract specifications recognise water quality protection objectives. Approval of gravel extraction proposals should include the conditions stated in Department's Water Quality Protection Note <i>Extractive Industries within PDWSAs</i>. Rehabilitate and revegetate the gravel pit in the catchment and remove and deep rip all access roads to it. 	<p>Gravel pits are focal points for illegal and sometimes destructive recreation activities usually involving vehicles. Recreational activities may be responsible for failure of rehabilitation in gravel pits.</p> <p>The gravel pit to the west of Canning Road in the southern part of the catchment is a particular focus for illegal recreation activities and blocking the access road has been ineffective.</p> <p>Gravel pits used for road maintenance require effective site management to reduce risks to water quality. New pits established by CALM are rehabilitated after use.</p> <p>Management guidelines are specified in the Water Quality Protection Note <i>Extractive Industries within PDWSAs</i>.</p>	<p>Acceptable activity with best management practices.</p> <ul style="list-style-type: none"> Pits should be rehabilitated immediately after decommissioning. Ensure gravel pits are outside the RPZ. Inspect water quality measures on site. Ensure contract specifications recognise water quality protection objectives. Approval of gravel extraction proposals should include the conditions stated in Department's Water Quality Protection Note <i>Extractive Industries within PDWSAs</i>. Rehabilitate and revegetate the gravel pit in the catchment and remove and deep rip all access roads to it.
Recreation					
Swimming	<p>There is a high risk of pathogen contamination associated with swimming, through direct contact with the water body.</p>	<p>Swimming, bathing, bodily contact with water and washing clothes in the reservoir and tributaries are prohibited, as is access to the RPZ, under <i>MWSSD Act</i> by-laws, as they have the potential to pollute surface water supplies (NHMRC and ARMCANZ, 1996). Swimming in the water body is not recommended by the Department of Health in public drinking water supply sources.</p>	<p>High</p>	<p>Swimming is prohibited in the reservoir and tributaries in the catchment.</p> <ul style="list-style-type: none"> Use signs and promotional material to ensure public awareness that swimming is prohibited in the reservoir and tributaries. Undertake after-hours surveillance with by-law enforcement. 	<p>Swimming is prohibited in the reservoir and tributaries in the catchment.</p> <ul style="list-style-type: none"> Use signs and promotional material to ensure public awareness that swimming is prohibited in the reservoir and tributaries. Undertake after-hours surveillance with by-law enforcement.

Table 1. continued

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
<p>Off-road driving (away from designated roads)</p> <ul style="list-style-type: none"> • 4WD • Motor cycles • Unlicensed cars 	<p>The potential risks associated with off-road driving include:</p> <ul style="list-style-type: none"> • turbidity from erosion of land, particularly on the steep slopes close to reservoir and from damage to vegetation; • hydrocarbon contamination from fuel spills from vehicles; • pathogen contamination through contact with the water body during vehicle crossings, and from people remaining in the catchment for extended periods and possibly camping; • contamination from associated vehicle dumping. 	<p>Medium</p> <p>Low</p> <p>Medium</p> <p>Medium</p>	<p>Off-road driving (away from designated roads) is prohibited under the MWSSD by-laws. The risks associated with this activity are significant, in particular turbidity caused by the erosion of tracks and other land. The gravel pit to the west of Canning Road in the southern part of the catchment is a particular focus for illegal recreation activities and blocking the access road has been ineffective. Despite the proximity of Victoria catchment to the metropolitan area, it has not been as heavily used for recreational off-road driving as some nearby catchment areas.</p>	<p><i>Off-road driving (away from designated roads) is prohibited in the catchment.</i></p> <ul style="list-style-type: none"> • Review the road network and close and rehabilitate roads not essential for forest operations and management or transport thoroughfare, to restrict access to off-road driving areas. • Use signs to advertise that off-road driving away from designated roads is prohibited in the catchment. • Continue to undertake surveillance with by-law enforcement. • Rehabilitate and revegetate the gravel pit in the catchment and remove and deep rip all access roads to it.
<p>Fishing and marroning</p>	<p>The major risks to water quality from fishing and marroning are:</p> <ul style="list-style-type: none"> • pathogen contamination from people remaining in close/direct contact with watercourses for extended periods, possible associated camping, and the use of bait; • turbidity from vehicle use close to the water body. 	<p>High</p> <p>Low</p>	<p>Human or animal contact with water poses an immediate contamination threat to water quality, and should be avoided. Marroning poses a particularly significant risk due to the direct contact with the water body for extended periods of time. There are additional risks associated with fishing and marroning through on-site camping and the presence of dogs close to watercourses. Fishing and marroning in the reservoir and tributaries is prohibited under MWSSD by-laws. By-laws are enforced by Water Corporation after-hours surveillance, but penalties are small and the activities continue. It is considered that stopping these activities is essential to protect water quality in such a strategic source.</p>	<p><i>Fishing and marroning is prohibited in the reservoir and tributaries in the catchment.</i></p> <ul style="list-style-type: none"> • Use signs and advertising material to ensure public awareness that fishing and marroning is not permitted. • Liaise with and advertise through Fisheries WA and fishing organisations. • Undertake after-hours surveillance of the catchment with by-law enforcement with the aim of ceasing activities. • Increase the penalties associated with offences under Part 4 of the MWSSD by-laws. • Consider alternative enforcement options under <i>Environmental Protection Act 1986</i>, i.e. Environmental Protection Policy.

Table 1. continued

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
Picnicking	<p>The potential risks to water quality include:</p> <ul style="list-style-type: none"> • pathogen contamination from people and potentially their pets (dogs), particularly close to the water body; and • rubbish dumping (this is difficult to control amongst such catchment users). 	<p>Medium</p> <p>Low/medium</p>	<p>The risk of contamination is increased as proximity to the reservoir is a desirable aspect of a picnic site. However, the risk is minimised where picnic sites and facilities are provided away from tributaries.</p> <p>The risk is greater for undesignated sites than picnicking in designated areas due to lack of management controls.</p>	<p>Picnicking is an acceptable activity at designated sites.</p> <ul style="list-style-type: none"> • Picnicking should not be permitted in the catchment other than at designated sites. • Ensure designated picnic areas are outside the RPZ and include appropriate facilities with no access to the water body or tributaries. • Use signs and brochures to advertise the importance of protecting drinking water quality. • Continue to enforce MWSSD Act by-laws that prohibit picnicking in undesignated sites within the catchment.

Table 1. continued

Activity	Potential Water Quality Risks		Management Priority	Consideration for Management	Recommended Protection Strategy
	Hazard				
<p>Bushwalking, orienteering and cycling</p> <ul style="list-style-type: none"> • Kattamorda Heritage Trail • Informal activities • Orienteering events • Munda Biddi mountain bike trail 	<p>The potential risks associated with these activities include:</p> <ul style="list-style-type: none"> • pathogen contamination from people remaining in the catchment for extended periods, particularly close to the reservoir or tributaries, and possibly camping; • increase in turbidity primarily from cyclists; and • spread of forest diseases particularly if individuals do not keep to tracks. 	<p>Medium</p> <p>Low</p> <p>Low</p>	<p>Bushwalking and cycling along designated tracks (such as the Kattamorda Heritage Trail and the Munda Biddi Trail) can be managed through education, which reduces the risk to water quality. It is essential that designated tracks be regularly inspected and maintained to minimise the risk of degradation and erosion.</p> <p>CALM is responsible for the establishment of the Munda Biddi Trail which is promoted as a self-guided cycle trail, thus public use is largely informal. Mention of public drinking water catchment protection objectives in information brochures is essential.</p> <p>Although the Kattamorda Trail is set up as a walk trail, its use by cyclists is uncontrolled and more likely to encourage off-track activity in the catchment. This type of access cannot be properly managed, and there is a risk of degradation and erosion of the area.</p> <p>One (known) organised orienteering event is held in the catchment each year, which is subject to CALM and Corporation approval. This event is well managed, and the groups willingly promote water quality issues. Organised orienteering events can be managed through approval and education. However, these events may encourage later visits by individuals.</p>	<p><i>Acceptable activity with conditions.</i></p> <ul style="list-style-type: none"> • No further trails to be developed in the catchment without consultation with relevant agencies. • Ensure an environmental management plan is developed, implemented and audited for the Kattamorda Heritage Trail and the Munda Biddi Trail which addresses water quality protection objectives, such as regular inspections and maintenance of the trail. • Ensure bushwalking and cycling, including designated trails and informal activity, are restricted to trails outside the RPZ. • Investigate the possibility of relocating the Kattamorda Heritage Trail outside the RPZ and away from feeder streams. • Use signs and brochures to advertise the MWSSD Act by-laws and the importance of protecting drinking water quality. • Consider alternative enforcement options under <i>Environmental Protection Act 1986</i>, i.e. <i>Environmental Protection Policy</i>. 	

Table 1. continued

Activity	Potential Water Quality Risks		Management Priority	Consideration for Management	Recommended Protection Strategy
	Hazard				
Horse riding <ul style="list-style-type: none"> • Pickering Brook Endurance Ride • Uncontrolled horse riding 	The risks associated with horse riding include: <ul style="list-style-type: none"> • pathogen contamination from people and animals remaining in the catchment for extended periods, particularly in areas close to watercourses. This would be further exacerbated if riders were to camp (refer to camping section above); • degradation of water quality from riders using the water body or watercourses for watering horses; • increase in turbidity from the use of horses and vehicles on unsealed roads and tracks (horses compact ground, contributing to increased overland runoff and thus turbidity); • fuel spills from associated vehicles accessing the trails; and • rubbish dumping (associated with uncontrolled riding not organised events). 	<p>Medium</p> <p>Medium</p> <p>Low</p> <p>Low</p> <p>Low</p>	Horse riding run by organised groups (e.g. Arabian Horse Association, AHA) can be managed through approval and education. The risk is reduced where horse riding occurs along roads or tracks away from the reservoir and tributaries, but is increased by uncontrolled riding by individuals. Except by permission of Department of Water and Water Corporation, it is prohibited to ride horses in the catchment under MWSSD by-laws except on public roads. The AHA currently runs the Pickering Brook Endurance Ride through the eastern half of Victoria catchment during one day in September each year. Conditions are applied, Water Corporation staff attend, and the AHA are required to submit an environmental management plan for approval each year.	Horse riding is prohibited in the catchment, unless on public roads. <ul style="list-style-type: none"> • Ensure horse riding is restricted to public roads outside the RPZ. • Use signs and advertising material to ensure public awareness that horse riding is restricted to public roads outside the RPZ. • Continue to undertake surveillance with by-law enforcement. • Continue to have Rangers attend organised horse-riding events for education purposes. • Ensure an environmental management plan is submitted, implemented and audited for the AHA, which addresses water quality protection objectives, such as ensuring horses stay on the trail and any horse manure is removed from the catchment and disposed of in a responsible manner immediately after the event. 	

Table 1. continued

Activity	Potential Water Quality Risks		Recommended Protection Strategy
	Hazard	Management Priority	
Illegal recreational hunting	<p>The major risk to water quality associated with hunting is pathogen contamination from:</p> <ul style="list-style-type: none"> • feral animal carcasses, and • people and dogs remaining in the catchment for extended periods and possibly camping. 	<p>Medium</p> <p>Medium</p>	<p><i>Recreational hunting is prohibited in the catchment.</i></p> <ul style="list-style-type: none"> • Use signs and advertising material (through local shooting clubs) to advertise that recreational hunting is not permitted in PDWSAs. • Continue surveillance of the catchment with by-law enforcement.
			<p>Hunting is prohibited in the catchment under MWSSD by-laws, unless authorised by CALM or the Department of Water for land management purposes. CALM approve hunting and trapping in the catchment for feral animal control. Water Corporation will only approve feral animal control by the trap-and-shoot method. Uncontrolled hunting and shooting introduce significant additional risks to water quality particularly due to associated camping and use of dogs, and also pose serious safety risks.</p> <p>It is essential that any hunting in the catchment as part of the feral animal control program is undertaken in a coordinated manner and minimises water contamination.</p> <p>Surveillance by Water Corporation Catchment Rangers currently reduces the occurrence of illegal hunting and the associated risks.</p>

Table 1. continued

Activity	Potential Water Quality Risks		Management Priority	Consideration for Management	Recommended Protection Strategy
	Hazard				
Rifle range	<p>The potential risks to water quality associated with this activity include:</p> <ul style="list-style-type: none"> • pathogen and nutrient contamination from poor waste management; • turbidity from stormwater runoff; and • potential leaching of lead from the projectiles under certain conditions. 	<p>Low</p> <p>Low</p> <p>Medium</p>	<p>The risks associated with this activity are low due to the few participants in the activity, and may be managed using best management practices.</p> <p>Collection and appropriate disposal of used bullets should prevent any future heavy metal contamination from their accumulation.</p> <p>A rifle range is not an approved land use in Priority 1 catchment areas and the site lies near the boundary of the proposed RPZ.</p>	<p><i>Acceptable activity with conditions.</i></p> <ul style="list-style-type: none"> • Investigate relocating the rifle range out of catchment. • Should this not be successful, survey an operation area for the rifle range, ensure the site operators are aware that the boundary should not overlap any stream zones, and manage this area for Priority 2 source protection. • Develop a management strategy with the site operator, which addresses water quality protection objectives including collection and appropriate disposal of waste lead, and signage on site. • Encourage the use of best management practices including regular pumping out of septic systems. • Catchment rangers should meet regularly with the operator to ensure water quality protection measures are in place and working effectively. 	

Table 1. continued

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
Golf course	<p>The potential risks to water quality include:</p> <ul style="list-style-type: none"> • pathogen contamination from people in the catchment; and • nutrient and pesticide contamination from the use of fertilisers and herbicides. 	<p>Medium</p> <p>Low</p>	<p>The golf course is situated on a reserve vested with the Shire of Kalamunda, on the northern boundary of the catchment. The clubhouse and toilet facilities are located outside the catchment boundary. The course has a small amount of lawn watered with bore water, sand greens and unwatered fairways and is thus unlikely to have a large impact on the water source.</p>	<p><i>Acceptable activity with conditions.</i></p> <ul style="list-style-type: none"> • Manage the area for Priority 2 source protection. • Develop a management strategy with the operator, which addresses water quality protection objectives. • Encourage the use of best management practices. • Catchment rangers should meet regularly with the operator to ensure water quality protection measures are in place and working effectively.
Rubbish dumping	<p>The potential risks associated with rubbish dumping include:</p> <ul style="list-style-type: none"> • pathogen contamination from domestic rubbish; and • nutrient, chemical, heavy metal and fuel contamination from domestic, building or industrial waste, and the dumping of stolen cars. 	<p>Medium</p> <p>Medium</p>	<p>Rubbish dumping is often associated with informal or unauthorised recreation or access to the catchment. Rubbish dumping has increased since the closure of the local rubbish tip.</p> <p>As all roads and tracks in the State forest are open to the public, control of access is a major issue in the catchment.</p>	<p><i>Rubbish dumping is prohibited in the catchment.</i></p> <ul style="list-style-type: none"> • Continue to develop a coordinated inter-agency plan to reduce rubbish dumping in the catchment. • Review road network and close roads not essential for forest operations and management or transport thoroughfare, to limit public access. • Use signs and advertising material to advertise that rubbish dumping is not permitted. • Continue to undertake surveillance with by-law enforcement.

Table 1. continued

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
Water Corporation and Water and Rivers Commission Land				
Unauthorised recreation <ul style="list-style-type: none"> • Off-road vehicle use • Hunting • Bushwalking • Camping CALM activities Approved recreation	The potential risks associated with these activities have been discussed in detail in previous sections. There are also additional risks of erosion associated with plantations established on Commission land.	Medium	The Water Corporation and Department of Water own several properties in the catchment, most of which are along Canning Road in the south of the catchment. The properties are used extensively for unauthorised recreation and illegal rubbish dumping. These activities may be controlled through the use of trespassing laws. A transition period would be necessary before laws were enforced...	Unauthorised recreation is prohibited on the Department of Water's land in the catchment. <ul style="list-style-type: none"> • Investigate the need for rehabilitation of stream zones with native vegetation. • Prohibit unauthorised access to the Department's properties under trespass laws. • Maintain signs to ensure public awareness of the private ownership of the properties. • Undertake surveillance of the Department's properties with enforcement of trespass laws. • Refer to previous sections for protection strategies for CALM approved/managed activities. • Refer to previous sections for protection strategies for approved recreation.

Table 1. continued

Activity	Potential Water Quality Risks		Management Priority	Consideration for Management	Recommended Protection Strategy
	Hazard				
Other Land Uses					
Major roads <ul style="list-style-type: none"> • Shire roads • Main roads 	<p>The potential risks to water quality include:</p> <ul style="list-style-type: none"> • fuel and chemical spills from vehicles and their loads; • herbicides from weed control on road verges; • turbidity from erosion of unsealed roads and verges; • increased turbidity created during construction of roads and associated heavy machinery movement; and • import of pathogens by motorists or their vehicle loads. 	<p>Medium</p> <p>Medium</p> <p>Medium</p> <p>Medium</p> <p>Low</p>	<p>The main road that intersects the catchment is Canning Road, which passes through the centre of the catchment in a north-south direction. Canning Road is a major transport route linking Welshpool Road and Brookton Highway, and is necessary for transportation and operations in the area. The risks associated with Canning Road are increased by the proximity to the water body. Canning Road passes within 1.6 km of the reservoir and crosses two of the three main tributaries to the reservoir (including Munday Brook). Some management guidelines are specified in the Water Quality Protection <i>Note Roads in Sensitive Environments</i>.</p>	<p><i>Best management practices are required for all roads in the catchment.</i></p> <ul style="list-style-type: none"> • Develop a management and maintenance plan for shire roads and main roads that addresses water quality protection objectives and risks, including appropriate road construction and maintenance, providing adequate drainage and control of runoff and spills, and weed control. • Undertake road construction and maintenance to avoid water source contamination risks. • Ensure road upgrades follow alignments and incorporate measures to avoid or minimise water source contamination risks. • Restrict development of new roads through the catchment. • Ensure an operative emergency response procedure exists and that the Local Emergency Management Authority (LEMA) is aware of PDWSA boundaries. • Use signs along roads to inform people that they are in a public drinking water supply catchment, and display the emergency contact number for use in the event of a spill. 	

Table 1. continued

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
Infrastructure maintenance <ul style="list-style-type: none"> • Power lines • Telephone lines and towers • Pipelines • Associated roads • Bridges 	The major risks associated with these activities are: <ul style="list-style-type: none"> • turbidity due to clearing of vegetation, use of unsealed roads and tracks and of heavy machinery on such tracks; • herbicides from weed control; and • hydrocarbon contamination from fuel spills from vehicles and machinery. 	Medium Low Low	Maintenance is necessary for the operation of the infrastructure. However, the risks to water quality associated with maintenance need to be managed, particularly in close proximity to watercourses. The Department's Statewide Policy Number 2 <i>Pesticide Use in Public Drinking Water Source Areas</i> should be considered when dealing with this hazard. There are also restrictions on the use of pesticides in catchment areas reflected in PSC88 (Department of Health, 1993). PSC88 is currently being updated.	Best management practices should be followed for all maintenance in the catchment. <ul style="list-style-type: none"> • Ensure that all agencies with responsibilities and their maintenance contractors are aware of PDWSA locations and that appropriate best management practices are followed whilst within a drinking water catchment. • Ensure responsible agencies adhere to relevant policies.

Table 1. continued

Activity	Potential Water Quality Risks		Management Priority	Consideration for Management	Recommended Protection Strategy
	Hazard				
Pumpback from Bickley Reservoir	<p>Importing water from the Bickley Reservoir introduces risks to Victoria catchment water, through blending with water of varying quality.</p> <p>There is also a risk of adversely affecting water quality through improper management of the inflow and outflow system, which may result in inadequate mixing of the imported water.</p>	<p>High</p> <p>Medium</p>	<p>The volume of water that the pumpback provides varies between 30 – 40 percent of the total water supplied to the Perth metropolitan area from the Victoria Reservoir. However for the past two years this volume has gone up between 25 percent and 50 percent as Bickley Reservoir is being supplemented by a groundwater transfer from the main supply.</p> <p>The operation of Bickley pumpback to import water to Victoria Reservoir is of concern for water quality because the quality of water in Bickley Reservoir is usually significantly lower than that in Victoria, and the risks to water quality in Bickley catchment are significantly greater.</p> <p>In general Victoria Reservoir is not used for supply when Bickley pumpback is operating, and a one month buffer time is maintained without pumping from Victoria following the last pumpback from Bickley.</p> <p>The strategies detailed throughout this table propose to manage the Victoria catchment to an agreed standard. The implementation of these strategies, together with an agreed standard of management in the Bickley catchment, will provide the most essential initial barriers to water contamination in the Integrated Water Supply System (IWSS).</p>	<p><i>Necessary for water supply operations.</i></p> <ul style="list-style-type: none"> Develop and implement the source protection planning process for the Bickley Reservoir catchment, to be used in conjunction with this plan to ensure protection to the highest achievable standard. Investigate methods of managing the inflow and outflow of the Victoria Reservoir to assist in mixing of the imported water through the reservoir. Continue to monitor the quality of water sourced from the Bickley Reservoir to ensure the imported water will not impair supply to the IWSS from Victoria Reservoir. 	

Recommendations

1. Amend the existing Victoria Reservoir Catchment Area under the *Metropolitan Water Supply, Sewerage and Drainage Act 1909* (Department of Water).
2. The Metropolitan Region Scheme and the Town Planning Schemes for the Shire of Kalamunda, City of Gosnells and City of Armadale should recognise priority classification areas and protection zones assigned to land in the Victoria Reservoir Catchment Area (Shire of Kalamunda, City of Gosnells and City of Armadale).
3. Ensure that the Water Corporation are advised of development and works proposals in the Victoria Reservoir Catchment Area that are likely to impact on water quality. Proposals that are inconsistent with the Department's Land Use Compatibility Table and Water Quality Protection Notes and Guidelines should be referred to the Department of Water for assessment and recommendation (Local and State government agencies and all key stakeholders).
4. Develop a management plan for shire roads and main roads that addresses water quality protection objectives. The development of new roads through the catchment should not be promoted (Main Roads WA, Shire of Kalamunda, City of Gosnells and City of Armadale).
5. Provide information and encourage private landowners to adopt best management practices (Department of Water and Water Corporation).
6. Work with the owner of the old fuel station to ensure the underground storage tanks are removed and clean-up of any contaminated soil occurs. If this is not possible, environmental assessment around the storage tanks should be conducted on a regular basis (Department of Water, Department of Environment and Water Corporation).
7. Ensure that personnel dealing with WESTPLAN – HAZMAT incidents in the Victoria Reservoir Catchment Area are given ready access to a locality map of the catchment area and training to understand the potential impacts of spills on the surface water resource (Water Corporation).
8. Ensure that signs are installed and maintained along the boundaries of the catchment area and proposed Reservoir Protection Zone to define the areas and to promote public awareness of the importance of protecting drinking water quality (Water Corporation).
9. Continue the implementation of the catchment surveillance program and associated by-law enforcement in the Victoria Reservoir Catchment Area (Water Corporation).
10. Develop and implement environmental management plans for any recreational events within the catchment under guidance of the Water Corporation (WC). The WC should audit plans after each event. Any new proposals would also require such a plan (Organisers of approved recreational events).
11. Ensure designated picnic areas are outside the Reservoir Protection Zone and include appropriate facilities with no access to the water body (Local and State government agencies).

12. Develop environmental management strategies with both the rifle range and golf course site operators, and encourage the use of best management practices, and management of spent projectiles. After the establishment of these strategies catchment Rangers should meet biannually with the operators to ensure water quality protection measures are in place and that they are working effectively (Water Corporation, Department of Environment and Department of Water).
13. A coordinated inter-agency plan is developed to reduce rubbish dumping in the catchment (Department of Water and Water Corporation).
14. Stream zones and other areas of this catchment in Water Corporation, the Department of Water or other government ownership are assessed for the need for rehabilitation, and rehabilitation with native species carried out where necessary (Water Corporation, Department of Environment and Department of Water).
15. A Drinking Water Source Protection Plan for the Victoria Reservoir catchment should be developed and implemented by Department of Environment, Department of Water and Water Corporation to ensure water supplied to the Integrated Water Supply System is of the highest achievable standard (Department of Water).
16. Strategies detailed in Table 1. Land Use, Potential Water Quality Risks and Recommended Strategies are adopted (Local and State government agencies).
17. A review of this plan is undertaken within five years to determine the status of the water reserve and level of implementation of these recommendations (Department of Water).

References

- Australian Forest Growers (AFG), 1997, Code of Practice for Timber Plantations in Western Australia.*
- ARMCANZ and ANZECC, 1996, *Draft Rural Land Uses and Water Quality: A Community Resource Document*. Agriculture and Resource Management Council of Australia and New Zealand and Australian and New Zealand Environment and Conservation Council.
- Burne, H., 2001, The condition of gravel pits in surface drinking water catchments and their potential to affect water quality. Water Corporation internal report. File No: JT1 2001 03470 V01.
- Department of Conservation and Land Management, 1999a, *Manual of Management Guidelines for Timber Harvesting in Western Australia*. Dept. of Conservation and Land Management.
- Department of Conservation and Land Management, 1999b, *Code of Practice for Timber Plantations in Western Australia*. Australian Forest Growers, Dept. of Conservation and Land Management.
- Conservation Commission of Western Australia, 2004, *Forest Management Plan 2004-2013*.
- Department of Water, 2004, Water Quality Protection Notes, *Land Use Compatibility in Public Drinking Water Source Areas*. Perth. See: <http://water.wa.gov.au> select Publications>Water Quality Protection Notes.
- Forest Products Commission (FPC), 2003, *Contractors' Timber Harvesting Manual – South West Native Forests*.
- Geldreich E.E., 1996, 'Pathogenic agents in freshwater resources', *Hydrological Processes*, Volume 10, pp. 315-333.
- Government of Western Australia, May 2001, *State Water Quality Management Strategy, No. 1 Framework for Implementation*. Report SWQ 1.
- Grimmond, T.R., Radford, A.J. and Brownridge, T., 1988, 'Giardia carriage in aboriginal and non-aboriginal children attending urban day-care centres in South Australia', *Australian Paediatric Journal*, Volume 24, pp. 304-305.
- Health Department of Western Australia, 6/1999, Understanding Septic Tank Systems. Environmental Health Guide, Environmental Health Service EHS 29. See: <http://www.population.health.wa.gov.au> select Environmental Health>wastewater management>resources>wastewater management.
- Health Department of Western Australia, 9/1998, Aerobic Treatment Units. Environmental Health Guide, Environmental Health Service EHS 26. See: <http://www.population.health.wa.gov.au> select Environmental Health>wastewater management>resources>wastewater management.
- King and Wells, 1990, *Darling Range Rural Land Capability Study*. Land Resource Series No. 3., Dept. of Agriculture, W.A.

NHMRC and ARMCANZ, 1996, *Australian Drinking Water Guidelines*. National Health and Medical Research Council and Agriculture and Resource Management Council of Australia and New Zealand.

South Australian EPA, 2003, *The State of Health of the Mount Lofty Ranges Catchments from a Water Quality Perspective*. See: <http://www.epa.sa.gov.au/> select publications> water>Mount Lofty Ranges Watershed protection office.

Western Australian Planning Commission, 1997, *State Planning Strategy*. Perth.

Water and Rivers Commission, 2000, Statewide Policy No. 2 *Pesticide Use in Public Drinking Water Source Areas*. Perth. See: <http://drinkingwater.water.wa.gov.au> select policy.

Acronyms

Alcoa	Alcoa World Alumina - Australia
ADWG	Australian Drinking Water Guidelines
ANZECC	Australia and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
CALM	Department of Conservation and Land Management
CAWS Act	Country Areas Water Supply Act 1947
DDT	Dichlorodiphenyltrichloroethane
DoE	Department of Environment
DRA	Disease Risk Area
DWSPP	Drinking Water Source Protection Plan
FPC	Forest Products Commission
GL	Gigalitre, a thousand million litres
HAZMAT	Hazardous materials
IWSS	Integrated Water Supply System
LEMA	Local Emergency Management Authority
ML	Megalitre. 1 million litres
MMPLG	Mining and Management Planning Liaison Group
MOG	Mining Operation Group
MWSSD Act	Metropolitan Water Supply, Sewerage and Drainage Act 1909
NHMRC	National Health and Medical Research Council
P1	Priority 1 - priority classification for land use
P2	Priority 2 – priority classification for land use
P3	Priority 3 – priority classification for land use
PDWSA	Public Drinking Water Source Area
PZ	Prohibited Zone
RIWI Act	Rights in Water and Irrigation Act 1914
RPZ	Reservoir Protection Zone
WC	Water Corporation
WRC	Water and Rivers Commission

Glossary

Aesthetic Guideline Levels	NHMRC guideline level ascribed for acceptable aesthetic quality of drinking water.
Allocation	The quantity of surface water permitted to be abstracted by a licence, usually specified in gigalitres per year (GL/a).
Alluvium (alluvial)	Detrital material which is transported by streams and rivers and deposited.
Aquifer	A geological formation or group of formations able to receive, store and transmit significant quantities of water.
BMP	Best Management Practice (defined in Section 6.3)
Catchment	The area of land which intercepts rainfall and contributes the collected water to surface water (streams, rivers, wetlands) or groundwater.
Diffuse Source Pollution	Pollution originating from a widespread area e.g. urban stormwater runoff, agricultural runoff.
Effluent	The liquid, solid or gaseous wastes discharged by a process, treated or untreated.
Groundwater	Water which occupies the pores and crevices of rock or soil.
Health Guideline Level	NHMRC guideline level ascribed for acceptable drinking water quality for human health.
Hydrogeology	The study of groundwater, especially relating to the distribution of aquifers, groundwater flow and groundwater quality.
IWSS	The Integrated Water Supply System provides water to Perth, Mandurah, Pinjarra, Harvey and the Goldfields and Agricultural regions, servicing approximately 1.5 million people. Fifty percent of the water is from surface water catchments, 50 percent is from groundwater. Refer to Figure 1 within Water Corporation's <i>Perth's Water Balance – The Way Forward</i> for a diagrammatic representation.
LGA	Local Government Authority (in this case Shire of Kalamunda, City of Armadale or City of Gosnells)
Leaching / Leachate	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.
m AHD	Australian Height Datum. Height in metres above Mean Sea Level +0.026 metres at Fremantle.
Nutrient Load	The amount of nutrient reaching the waterway over a given time (usually per year) from its catchment area.

Nutrients	Minerals dissolved in water, particularly inorganic compounds of nitrogen (nitrate and ammonia) and phosphorus (phosphate) which provide nutrition (food) for plant growth. Total nutrient levels include the inorganic forms of an element plus any bound in organic molecules.
PDWSA	Public Drinking Water Supply Areas are Underground Water Pollution Control Areas, catchment areas or water reserves established under the <i>Metropolitan Water Supply, Sewerage and Drainage Act 1909</i> or <i>Country Area Water Supply Act 1947</i> .
Pesticides	Collective name for a variety of insecticides, fungicides, herbicides, algicides, fumigants and rodenticides used to kill organisms.
Point Source Pollution	Specific localised source of pollution, e.g. sewage or effluent discharge, industrial waste discharge.
Pollution	Water pollution occurs when waste products or other substances, e.g. effluent, litter, refuse, sewage or contaminated runoff, change the physical, chemical, biological or thermal properties of the water, adversely affecting water quality, living species and beneficial uses.
PDWSA	Public Drinking Water Source Areas are Underground Water Pollution Control Areas, catchment areas or water reserves established under the MWSSD or CAWS Act. PDWSAs are also referred to as drinking water catchments.
Runoff	Water that flows over the surface from a catchment area, including streams.
Scheme Supply	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 or irrigation use.
Storage Reservoir	A major reservoir of water created in a river valley by building a dam.
Stormwater	Rainwater which has run off the ground surface, roads, paved areas etc. and is usually carried away by drains.
Treatment	Application of techniques such as settlement, filtration and chlorination to render water suitable for specific purposes including drinking and discharge to the environment.
Underground Water Pollution Control Area (UWPCA)	An area defined under the <i>Metropolitan Water Supply, Sewerage and Drainage Act</i> , in which restrictions are put on activities that may pollute the groundwater.
Wastewater	Water that has been used for some purpose and would normally be treated and discarded. Wastewater usually contains significant quantities of pollutant.
Water Quality	The physical, chemical and biological measures of water.

Appendices

Appendix 1 Water Quality Results provided by the Water Corporation

Appendix 2 Best Management Practices documents for activities in PDWSAs

APPENDIX 1

Water Quality Results provided by the Water Corporation

The Water Corporation has monitored the raw (source) water quality from Victoria Reservoir in accordance with the Australian Drinking Water Guidelines (ADWG) and interpretations agreed to with the Department of Health. The raw water is regularly monitored for:

a. Health related characteristics

- Microbiological Contaminants
- Health Related Chemicals

b. Aesthetic characteristics– (Non-health related)

Following is data representative of the quality of raw water in Victoria Reservoir. In the absence of specific guidelines for raw water quality, the results have been compared with ADWG values set for drinking water. Results that exceed 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. For information on the quality of drinking water supplied in the Perth Region refer to the most recent Water Corporation Drinking Water Quality Annual Report at: <http://www.watercorporation.com.au/dwq/index.cfm>.

Health Related Characteristics - Victoria Reservoir Raw Water

• **Microbiological Contaminants**

Microbiological testing of raw water samples is conducted on a weekly to monthly basis, particularly during summer and autumn. Thermotolerant coliform counts are used as an indicator of the degree of faecal contamination of the raw water from warm-blooded animals. A count less than 20 colony forming units (cfu) per 100 millilitre (mL) is typically associated with low levels of contamination and is used as a microbiological contamination benchmark (WHO, 1996).

During the review period of January 1999 to October 2004 the raw water in Victoria Reservoir was sampled for thermotolerant coliforms 226 times. Positive thermotolerant counts were recorded in 56 percent of samples. Five percent of the positive samples had thermotolerant coliform counts greater than 20 cfu/100 mL.

These percentages are higher than in some of the larger more pristine hills drinking water catchments further from population centres, but lower than some of the catchments with greater human impact. This is a cause for concern as any positive result in *disinfected* drinking water is considered an exceedence of the ADWG guideline level and it implies that there are insufficient barriers within the catchment to prevent contamination of the raw water. These results show the importance of disinfection and will focus the 'catchment protection' for this reservoir on those land uses or activities that have the potential to impact bacterial contamination.

Turbidity can affect microbiological activity in drinking water, by protecting pathogenic micro-organisms from the effects of disinfection, promoting bacterial growth and exerting a significant disinfectant demand. A turbidity of less than one NTU is desirable for effective disinfection. Adequate disinfection may be achieved at higher turbidity levels (particularly up to the guideline level of five NTU) however the efficiency of disinfection decreases with increasing turbidity. As such, the generally low turbidity levels recorded at Victoria Reservoir (see Aesthetic Characteristics section below) ensure a relatively low risk associated with detected microbiological contamination, but it is important that this is maintained.

The WC also monitor for cyanobacteria ('*Blue Green Algae*') in drinking water catchments that are considered at risk of having elevated levels of cyanobacteria, for example catchments with a significant proportion of agricultural land or a history of high nutrient levels. The WC is guided by the National Protocol for the Monitoring of *Cyanobacteria and their Toxins in Surface Fresh Waters* (ARMCANZ, 2003). This document is currently only in draft and therefore the alert levels are yet to be finalised. The results of the first cyanobacteria monitoring on 28 July 2004 indicate that cyanobacteria counts and densities in Victoria Reservoir were well within health limits.

- **Health Related Chemicals**

Health related chemicals include inorganics, heavy metals, industrial hydrocarbons and pesticides. Health related chemicals that have been measured at detectable levels in the source between January 1999 and October 2004 are summarised in the following table. All values are in milligrams per litre (mg/L).

Parameter	Units	ADWG Health Guideline Value*	Victoria Reservoir	
			Range	Median
Metals				
Barium	mg/L	0.7	0.017-0.06	0.02
Boron	mg/L	4	0.02-0.036	0.03
Inorganics				
Fluoride	mg/L	1.5	<0.1-0.35	<0.1
Nitrate + Nitrite (as N)	mg/L	11.3	0.4-0.4	0.04
* 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.				

The above parameters have been detected in the raw water at concentrations well below ADWG health guideline values, and pose no health concern. Monitoring of health parameters is ongoing.

Aesthetic characteristics - Victoria Reservoir raw water

Aesthetic water quality analysis for raw water from Victoria Reservoir is summarised in the following table. These values were taken from continual monitoring for the period January 1999 to October 2004. All values are in milligrams per litre (mg/L) unless stated otherwise. The water quality parameters that have on occasion exceeded the ADWG aesthetic guideline for supplied drinking water are shaded.

Parameter	Units	ADWG Aesthetic Guideline Value*	Bickley Reservoir	
			Range	Median
pH		6.5 – 8.5	7.66 - 7.79	7.72
Turbidity	NTU	5	0.11 - 3.6	1.5
True colour	TCU	15	2 - 5	3
Conductivity	mS/m	-	42 - 51	48.5
Total Dissolved Solids#	mg/L	500	219 - 252	242
Iron (unfiltered)	mg/L	0.3	0.056 - 0.3	0.129
Manganese (unfiltered)	mg/L	0.1	<0.002 - 0.014	0.003
Aluminium (unfiltered)	mg/L	-	0.038 - 0.26	0.17
Sodium	mg/L	180	62 - 62	62
Potassium	mg/L	-	2.2 - 2.8	2.5
Calcium	mg/L	-	9 - 9	9
Magnesium	mg/L	-	9 - 9	9
Hardness (as CaCO ₃)	mg/L	200	59 - 59	59
Alkalinity (as HCO ₃)	mg/L	-	30 - 30	30
Chloride	mg/L	250	120-120	120
Sulphate	mg/L	250	20 - 20	20
Silica (as SiO ₂)	mg/L	-	3.7 - 3.7	3.7
Filterable organic carbon	mg/L	-	2.4 - 2.4	2.4
<p># Total Dissolved Solids is not measured in routine sampling. These figures were derived from the conductivity figures by regression.</p> <p>* An aesthetic guideline value is the concentration or measure of a water quality characteristic that is associated with good quality water.</p>				

The raw water from Victoria Reservoir is of good quality and complies with ADWG aesthetic guidelines.

Appendix 2 Best Management Practice Documents for Activities in PDWSAs

Waste Management:

- Health Department of Western Australia, 6/1999, *Understanding Septic Tank Systems*. Environmental Health Guide, Environmental Health Service EHS 29. Available from: www.population.health.wa.gov.au.
- Health Department of Western Australia, 9/1998, *Aerobic Treatment Units*. Environmental Health Guide, Environmental Health Service EHS 26. Available from: www.population.health.wa.gov.au.

Drainage:

Overland runoff should not be channelled into streams. Infiltration into soil should be aided at every opportunity.

- Lloyd, B. and Van Delft, R., 2001, *Erosion and Sediment Control Manual for the Darling Range, Perth Western Australia*. Upper Canning/Southern Wungong Catchment Team, Agriculture WA.

Buffers:

Vegetated buffers should be maintained along all streamlines, whether currently flowing or not.

- Department of Conservation and Land Management, 1999, *Manual of Management Guidelines for Timber Harvesting in Western Australia*, Department of Conservation and Land Management. Available from: www.naturebase.net/forest_facts/sy_review/manuals/manual_of_harvesting_specifications/index.html.
- National Health & Medical Research Council and Agriculture & Resource Management Council of Australia and New Zealand, 1996, *Australian Drinking Water Guidelines*, NHMRC and ARMCANZ. Available from: www.nhmrc.gov.au/publications/synopses/eh19syn.htm.
- Water and Rivers Commission, 2001, *A Review of Stream and River Logging Buffers in Western Australia, to Ensure their Adequacy in Protecting Waterways from Salinity, Degradation and Turbidity*, Water and Rivers Commission report to the Conservation Commission of Western Australia.

Pesticide Application:

Should be minimised in catchment areas. For specific needs of crops and best practice contact Department of Agriculture.

- Health Department of WA, 1993, *Use of Herbicides in Public Drinking Water Source Areas*. PSC 88 (Public Service Circular 88). Government of Western Australia. Available from: www.population.health.wa.gov.au/environmental/resources/use%20of%20herbicides%20in%20water%20catchment%20areas.pdf.
- Water and Rivers Commission, 2000, Statewide Policy No. 2 *Pesticide Use in Public Drinking Water Source Areas*, Water and Rivers Commission. Available from: www.water.wa.gov.au.
- Water and Rivers Commission, 2001, Draft Water Quality Protection Note *Pesticide Use in Sensitive Environments*, Water and Rivers Commission. Available from: <http://www.water.wa.gov.au>

Nutrient Application:

Should be minimised in catchment areas. For specific needs of crops contact Department of Agriculture.

- Water and Rivers Commission, 1998, Water Quality Protection Note: *Nutrient and Irrigation Management Plan*, Water and Rivers Commission. Available from: www.water.wa.gov.au.

Forest Management:

- Department of Conservation and Land Management, 1999, *Manual of Management Guidelines for Timber Harvesting in Western Australia*, Department of Conservation and Land Management, Available from: www.naturebase.net/forest_facts/sy_review/manuals/manual_of_harvesting_specifications/index.html.
- Department of Conservation and Land Management, 1999, *Code of Practice for Timber Harvesting in Western Australia*, Department of Conservation and Land Management. Available from: www.naturebase.net/forest_facts/sy_review/manuals/code_of_harvesting_manual/code_timberharv_practice.pdf.
- Australian Forest Growers, 1997, *Code of Practice for Timber Plantations in Western Australia*, Australian Forest Growers, Department of Conservation and Land Management.
- Forest Products Commission, 2003, *Contractors' Timber Harvesting Manual – South West Native Forests*, Forest Products Commission.

Forest Fire Management:

Control burning should be conducted on a scale and at a frequency to minimise erosion with overland runoff into reservoirs. Therefore, only small proportions of land in a catchment should be burnt in any one year. Guidelines on how to address water quality protection objectives in the Controlled Burning Prescription should be documented by CALM, Department of Water and Water Corporation.

Bauxite Mining:

- White, A, 2001, *Bauxite Mining Operations*. Environmental Management Manual Document No: 42354. Alcoa World Alumina - Australia.
- Water and Rivers Commission, 2000, Water Quality Protection Guidelines (Nos 1 – 11): *Mining and Mineral Processing*, Water and Rivers Commission. Available from: www.water.wa.gov.au.

Motor Rally Events:

- Water Corporation, 2002, *Managing Motoring Events in Catchments*, Draft. Source Protection Operations Management Manual SG 097.2. Water Corporation.
- Water and Rivers Commission, 2003, *Policy and Guidelines for Recreation within Public Drinking Water Source Areas on Crown Land*, Statewide Policy No. 13. Water and Rivers Commission. Available from: www.water.wa.gov.au.

Mechanical Servicing and Workshops:

- Water and Rivers Commission, 2002, Water Quality Protection Note *Mechanical Equipment Washdown*, Water and Rivers Commission. Available from: <http://www.water.wa.gov.au>

- Water and Rivers Commission, 2002, Water Quality Protection Note *Mechanical Servicing and Workshops*, Water and Rivers Commission. Available from: <http://www.water.wa.gov.au>.

Recreation in PDWSAs:

- Water and Rivers Commission, 2003, *Policy and Guidelines for Recreation within Public Drinking Water Source Areas on Crown Land*, Statewide Policy No. 13. Water and Rivers Commission. Available from: www.water.wa.gov.au.

Horse Facilities and Activities:

- Water and Rivers Commission, Western Australian Horse Council (Inc), Department of Environmental Protection, Department of Health, 2002. *Environmental Management Guidelines for Horse Facilities and Activities*. WQP Guideline 13. Available from: <http://www.water.wa.gov.au>

Research Projects:

Participants should be educated on personal hygiene in a PDWSA and erosion prevention, prior to any activity occurring.

Major Roads, Roads and Tracks, Infrastructure Maintenance:

Drainage must be controlled to prevent soil erosion and minimise sediment transport. Chemical application to control vegetation should be minimised.

- Lloyd, B. and Van Delft, R., 2001, *Erosion and Sediment Control Manual for the Darling Range, Perth Western Australia*. Upper Canning/Southern Wungong Catchment Team, Department of Agriculture.

Extractive Industries / Gravel Pits:

- Water and Rivers Commission, 2000, Water Quality Protection Note: *Extractive Industries within Public Drinking Water Source Areas*, Water and Rivers Commission. Available from: www.water.wa.gov.au.

Chemical and Fuel Storage:

- Water and Rivers Commission, 1999, Water Quality Protection Note *Above Ground Chemical Storage Tanks within Public Drinking Water Source Areas*, Water and Rivers Commission.
- Water and Rivers Commission, 1998, Water Quality Protection Note *Temporary Skid Mounted Fuel Transfer and Storage within Public Drinking Water Source Areas*, Water and Rivers Commission.
- Water and Rivers Commission, 2000, Water Quality Protection Note *Temporary Above Ground Chemical Storage within Public Drinking Water Source Areas*, Water and Rivers Commission.
- Water and Rivers Commission, 1998, Water Quality Protection Note *Temporary Above Ground Fuel Storage within Public Drinking Water Source Areas*, Water and Rivers Commission.
- Water and Rivers Commission, 2002, Water Quality Protection Note *Toxic and Hazardous Substances Storage within Public Drinking Water Source Areas*, Water and Rivers Commission.
- Water and Rivers Commission, 2002, Water Quality Protection Note *Chemical Spills – Emergency Response Planning*, Water and Rivers Commission.

Available from: <http://drinkingwater.water.wa.gov.au>

Publication feedback form

The Department of Water welcomes feedback to help us improve the quality and effectiveness of our publications. Your assistance in completing this form would be greatly appreciated.

Please consider each question carefully and rate them on a 1 to 5 scale, where 1 is poor and 5 is excellent (please circle the appropriate number).

How did you rate the quality of information?

1 2 3 4 5

How did you rate the design and presentation of this publication?

1 2 3 4 5

How can it be improved?

How effective did you find the tables and figures in communicating the data?

1 2 3 4 5

How can they be improved?

If you would like to see this publication in other formats, please specify. (e.g. CD)

Please cut along the dotted line on the left and return your completed response to:

Communications Manager
Department of Water
Perth Western Australia 6842
Phone: (08) 6364 7600
Fax: (08) 6364 7601

