



Department of Water
Government of Western Australia

Looking after all our water needs



Brookton Reservoir Catchment Area
drinking water source protection plan
Brookton town water supply



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Department of Water

Water resource protection series

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Department of Water

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Preface

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

The *Australian Drinking Water Guidelines* recommend a risk based, multiple barrier approach to protect public drinking water sources. Catchment protection is the first barrier, with subsequent barriers implemented at the water storage, treatment and distribution stages of a water supply system. Catchment protection requires an understanding of the catchment, the hazards and hazardous events that can compromise drinking water quality, and development of preventative strategies and operational controls to ensure the safest possible water supply.

This plan details the location and boundary of the drinking water catchment, which provides potable water to the Brookton town water supply. It discusses existing and future usage of the water source, describes the water supply system, identifies risks and recommends management approaches to address these risks and maximise protection of the catchment.

This plan should be used to guide state and local government land use planning decisions. It should be recognised in the Shire of Brookton Town Planning Scheme, 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 Brookton Reservoir catchment area.

The stages involved in preparing a drinking water source protection plan are:

Stages in development of a Plan		Comment
1	Prepare drinking water source protection assessment.	Prepared following catchment survey and preliminary information gathering.
2	Conduct stakeholder consultation.	Advice sought from key stakeholders using the assessment as a tool for information and discussion.
3	Prepare draft drinking water source protection plan.	Draft plan developed taking into account input from stakeholders and any additional advice received.
4	Release draft drinking water source protection plan.	Draft plan released for a six week public consultation period.
5	Publish approved drinking water source protection plan.	Final plan published after considering advice received in submissions. Includes recommendations on how to protect the catchment.

Summary

The Brookton Reservoir is located on a tributary of the Avon River, approximately 140 km south-east of Perth and about 5 km south-west of the town of Brookton. It is one of two local sources operated by the Water Corporation (the other is the Brookton Happy Valley water reserve) to supply the town of Brookton. Both local sources supplement the public drinking water supply provided by the Great Southern Town Water Supply to the town. Brookton services local rural industries that are based on sheep, cattle and wheat farming, and is the administrative centre for the Shire of Brookton. It has a population of approximately 600 people.

The existing Brookton Water Supply catchment area covers an area of approximately 6 km², located wholly within the Shire of Brookton. This plan proposes a new boundary that will cover a reduced catchment area of approximately 4.5 km². The Brookton Water Supply catchment area was proclaimed in 1959 under the *Country Areas Water Supply Act 1947* to ensure protection of the water source from potential contamination. It is recommended that the name of the Brookton Water Supply catchment area be changed to the Brookton Reservoir catchment area so the naming is consistent with other public drinking water source areas in the state. The catchment area will be referred to by its proposed name throughout this document (except where it is appropriate to refer to its old name).

This plan has been prepared to protect drinking water quality for public health reasons. The plan:

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

The aim of this drinking water source protection plan is to preserve water quality and water supply for the town of Brookton. A three-tiered approach to classifying and allocating protection zones for the water source will be employed. The proposed priority classifications are based on the strategic importance of the land, its zoning in the local planning scheme, land tenure and existing approved land use activities.

The Water Corporation has freehold ownership of Avon Location Lot 21413 which covers an area of approximately 3.6 km² within the gazetted Brookton Reservoir catchment area. Lot 21413 will be classified for Priority 1 (P1) source protection to provide the highest level of protection for the water source and to avoid potential contamination risks associated with surrounding land uses.

The remainder of land located within the upper reaches of the catchment is in private freehold ownership and has been cleared for agricultural use. Cereal cropping and, sheep grazing are the dominant types of land uses. It is proposed that this land be

classified for Priority 2 (P2) source protection. The management objective is to minimise risks to the water source, while allowing existing approved land uses to continue. Landholders should employ best management practice to preserve the water source values.

Future development proposals within the Brookton Reservoir catchment area should be carefully assessed to protect water quality. Proponents are required to seek advice from this department before approval of any proposed developments that are inconsistent with the water quality protection note *Land use compatibility in public drinking water source areas* or *Statement of Planning Policy No.2.7 – Public drinking water source policy*.

1 Drinking water supply system

1.1 Existing water supply system

Brookton Reservoir was constructed in 1916 and consists of a 9 metre high earth filled wall (see photo 1 Appendix B). The reservoir covers an area of 5.8 hectares and has a storage volume of 140 ML (see Figure 1).

The Brookton Reservoir is part of the Great Southern Town Water Supply (GSTWS), along with Harris Dam catchment area and the Brookton Happy Valley water reserve (BHVWR) (see Figure 2). Winter flows into Brookton Reservoir are used to supplement water delivered from Harris Reservoir, the main source for the GSTWS. Harris Reservoir currently provides about 50 per cent of Brookton's annual water requirements.

Water from the GSTWS is either transferred directly into the reticulation scheme at Wabbing Hill or stored in Brookton Reservoir. Groundwater from the BHVWR, which is north of Brookton town site, provides additional water during the summer months in order to meet the peak demand. Water from BHVWR is pumped into the reservoir or directly to Wabbing Hill transfer pump station during November to April when flows into the reservoir are reduced (see Figure 2).

The current number of water services in Brookton is 352 and consumption of water from the scheme has averaged 144 ML a year since 2003.

To be consistent with the naming of public drinking water source areas around the state, it is proposed to change the name of the Brookton Water Supply catchment area to the Brookton Reservoir catchment area. In this plan the catchment area will be referred to by its proposed name.

1.2 Water treatment

Water from Brookton Reservoir is chlorinated at the Wabbing Hill transfer pump station, which is adjacent to the reservoir. The water is also filtered using cartridge filters to remove any contaminants and particles in the water before supply to Brookton.

It should be recognised that although treatment and disinfection are essential barriers used to ensure a safe, good quality drinking water supply, catchment management and water source protection are fundamental 'first barriers' for the protection of water quality. The combination of catchment protection and treatment will deliver a more reliably safe drinking water supply to consumers. This approach is endorsed by the *Australian Drinking Water Guidelines (ADWG) 2004* (NHMRC & NRMCC 2004a) and reflects a risk based, catchment to consumer multiple barrier approach for the provision of safe drinking water to consumers.

1.3 Catchment details

1.3.1 Physiography

The Brookton Reservoir catchment area (BRCA) is contained within the Darling Range. The Darling Range forms part of the Archaean Shield composed largely of granite which has some invaded linear belts of metamorphosed sedimentary and volcanic rocks, some isolated occurrences of which remain (Schofield 1991). Thin sheetlike dolerite intrusions occur abundantly in the basement rock. Deep V-shaped valleys occur close to the scarp, with shallow soils and frequent rock outcrops. On moving inland, valleys are broader and more U-shaped.

Soils consist of granite covered by a weathered laterite hard cap and associated clays and include shallow sand over sheet laterite, gravelly duplex soils and grey sands. Upland laterites consist of sandy loams in a gravel matrix whilst gravels tend to become finer down slope, sometimes grading into sandy yellow earths in the lowest positions.

1.3.2 Climate

Brookton experiences a Mediterranean-type climate, characterised by warm, dry summers and cool, wet winters.

The long-term average annual rainfall for the catchment is about 460 mm. Most rain results from winter cold front systems that cross the south-west of Western Australia between May and August.

1.3.3 Hydrology

The Brookton Reservoir lies within the BRCA covering an area of approximately 6 km² and varies in elevation from 290 metres Australian Height Datum (AHD) at the reservoir to about 360 metres AHD at the head of the catchment.

Water inflow to the reservoir is mostly from surface water runoff over the winter months. The reservoir has one main feeder stream which is fed by a number of small watercourses throughout the catchment. There is also one smaller feeder stream that enters the reservoir to the north of the main stream.

Drainage channels have been constructed throughout the BRCA to increase inflow into the reservoir. Tracks throughout the catchment have also been engineered to increase run-off. The current long-term average yield from Brookton Reservoir is 60 ML/year.

1.4 Future water supply requirements

There are no plans to increase the capacity of Brookton Reservoir or extend the Brookton Happy Valley Wellfield. However, a 3 ML water storage tank is due to be

constructed that will replace the reservoir as storage for water from the GSTWS and Happy Valley water supplies. The tank water will flow to the Wabbing Hill transfer station where it will be chlorinated at the tank inlet, prior to being transferred to town for local consumption. It is considered that the GSTWS can adequately meet future increase in demand with current levels of supplementation from the two local sources. The decision to continue using Brookton Reservoir as a source is under review by the Water Corporation. Protection of the catchment area needs to continue pending the outcome of this review.

1.5 Protection and allocation

1.5.1 Existing water source protection

Brookton Water Supply catchment area was proclaimed in 1959 under the *Country Areas Water Supply Act 1947* (CAWS Act) to ensure protection of the water source from potential contamination. The gazetted catchment area is shown in Figures 1, 2 and 3.

1.5.2 Current allocation licence

Water resource use and conservation in Western Australia is administered by the Department of Water in accordance with the *Rights in Water and Irrigation Act 1914* (RIWI Act). Under this Act, the right to use and control surface and groundwater is vested with the Crown. This Act requires a licence to draw water from surface water and groundwater areas proclaimed under the Act (except for domestic and stock use) and all artesian wells throughout the state. The Water Corporation is licensed by the department to draw 60 ML/year from Brookton Reservoir.

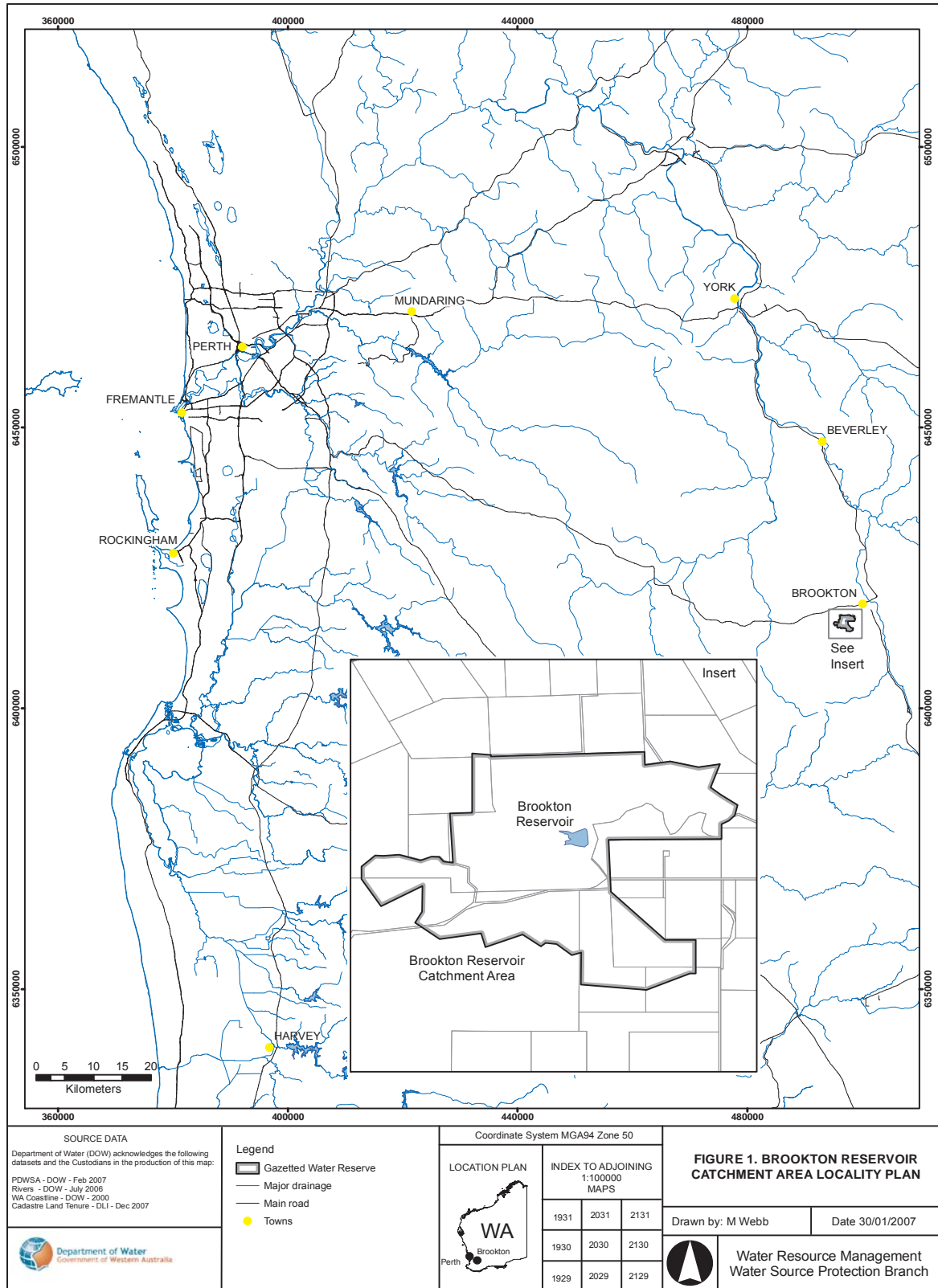
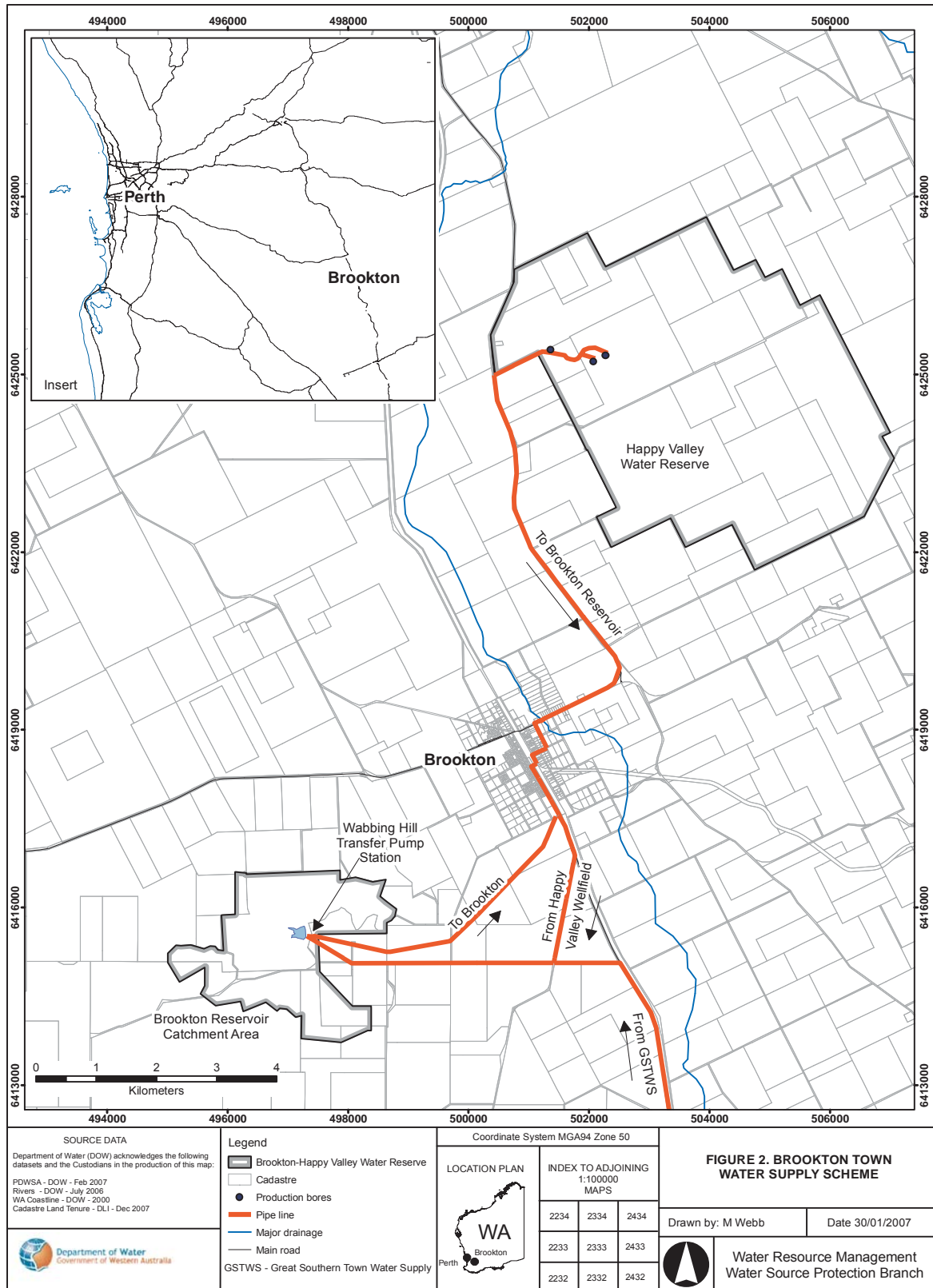


Figure 1 Brookton Reservoir catchment area locality plan



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Figure 2 Brookton town water supply scheme

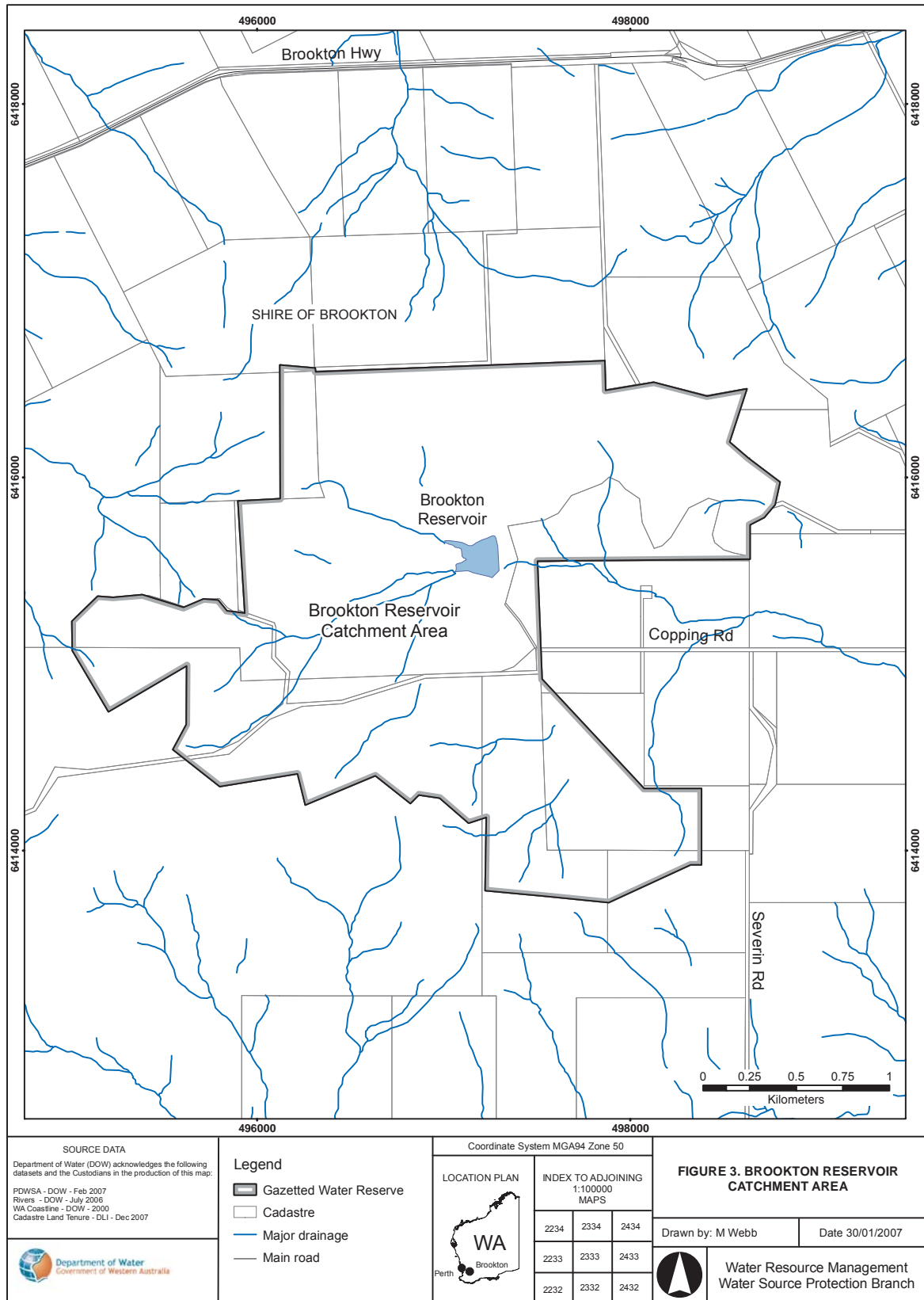


Figure 3 Brookton Reservoir catchment area

2 Water quality monitoring and contamination risks

The Water Corporation regularly monitors the raw water from the Brookton Reservoir catchment area (BRCA) for microbiological contamination, health related chemicals and aesthetic characteristics in accordance with the *Australian Drinking Water Guidelines* (ADWG) and the program set out in the *Brookton Water Resource Management Operation Strategy* (Kolman 2003). The results of this monitoring are reviewed by an intergovernmental committee, chaired by the Department of Health, called the Advisory Committee for the Purity of Water.

A water quality summary for the BRCA from February 2003 to February 2008 is presented in Appendix A. For more information on water quality, see the Water Corporation's most recent Drinking Water Quality Annual Report at www.watercorporation.com.au Water > Water Quality > Downloads > most recent Annual Report.

It should be noted that testing is conducted on raw water, and that all ADWG health limits are met following treatment before supply to consumers, with the exception of pH and iron (unfiltered) that is slightly above ADWG aesthetic value, which pose no risk to human health.

2.1 Microbiological contaminants

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

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

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

Pathogens may enter a water source through activities involving direct contact of people and domestic animals with the main water body or its tributaries (such as fishing, marroning and swimming). This primarily occurs through the direct transfer of

faecal material to the water (even a very small amount can cause contamination), or indirectly through runoff moving faecal material into the water.

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

The effect on people consuming drinking water that is contaminated with pathogens varies considerably, ranging from mild illness (such as stomach upset or diarrhoea) to hospitalisation and sometimes death. In 2000, in Walkerton, Canada, seven people died due to contamination by a pathogenic strain of *Escherichia coli* and *Campylobacter* in the town water source and supply (NHMRC & NRMCC 2004b). Preventing the introduction of pathogens into the water source is the most effective barrier in avoiding this public health risk.

Variable counts of *E.coli* have been regularly recorded in the Brookton Reservoir raw water. Brookton Reservoir is considered at a high risk of microbiological contamination because of activities within the catchment. However, management strategies are in place to reduce the contamination risk. Further investigation into *E.coli* counts and potential sources of contamination is required to determine the need for additional catchment management barriers.

2.2 Health related chemicals

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

Land use activities within the catchment can directly influence the effectiveness of water treatment. For example, off-road driving and driving on unauthorised tracks contributes to erosion and the uprooting of vegetation. Erosion results in the mobilisation of soil particles, which are released into the air and tributaries, increasing the turbidity of the main water body. Pathogens can adsorb onto these soil particles and may be shielded from the effects of disinfection. Increased turbidity also impacts upon other environmental constituents, that is, smothering riparian vegetation and reducing light transfer within the water column, which affects plant growth.

A number of chemicals (organic and inorganic) are of concern in drinking water from a health perspective because they are potentially toxic to humans. Chemicals usually occur in drinking water sources attached to suspended material such as soil particles and may result from natural leaching of mineral deposits or from different land uses (NHMRC & NRMCC 2004b)

Pesticides include agricultural chemicals such as insecticides, herbicides, nematicides (used to control nematodes, rodenticides and miticides (used to control mites). Contamination of a drinking water source by pesticides may occur as a result of accidental spills, incorrect or over use and leakage from storage areas. In such cases, prompt action is required to notify relevant authorities and clean up the spill. No pesticides have been detected in Brookton Reservoir.

Nutrients (such as nitrogen) can enter drinking water supplies from leaching of fertiliser, septic tanks, and from faeces of domestic animals (such as cattle grazing on the land). Nitrate and nitrite (ions of nitrogen) can be toxic to humans at high levels, with infants less than 3 months old being most susceptible (NHMRC & NRMMC 2004a).

Hydrocarbons (fuels, oils, solvents) are potentially toxic to humans, and harmful by-products may be formed when they are combined with chlorine in water treatment processes. Hydrocarbons can occur in water supplies from pollution events from vehicle accidents, refuelling and leakage from storage areas.

None of the health related water quality parameters measured at Brookton Reservoir exceeded health guideline values. These parameters will continue to be routinely monitored.

2.3 Aesthetic characteristics

Impurities in drinking water can affect the aesthetic qualities of water such as appearance, taste, smell and 'feel'. Such impurities are not necessarily hazardous to human health; for example, water that is cloudy and has a distinctive colour may not be harmful (NHMRC & NRMMC 2004b).

Iron and dissolved organic matter can affect the colour and appearance of water, and salinity can affect the taste. The ADWG set limits on water quality characteristics to meet the aesthetic requirements of consumers.

Some properties such as pH (a measure of acidity and alkalinity) can contribute to the corrosion and encrustation of pipes. The ADWG also set out aesthetic guidelines for these types of water quality characteristics.

The raw water quality measured from BRCA slightly exceeded ADWG aesthetic guidelines in pH, iron concentration, chloride, turbidity and total filterable solids by summation (TFSS). The pH of water samples taken from Brookton Reservoir has occasionally been below the ADWG aesthetic guideline of 6.5 – 8.5. Iron concentration (unfiltered) in some samples, slightly exceeded the aesthetic guideline value of 0.3 milligrams/litre (mg/L) (see Appendix A, Table 3). These are all naturally occurring variations and are not considered to be impacted by land use within the BRCA.

3 Land use and contamination risk

3.1 Existing land uses

The Water Corporation owns approximately 60 per cent of the currently gazetted catchment area, which incorporates about 45 per cent of the proposed catchment area boundary, including the majority of land immediately surrounding Brookton Reservoir. 55 per cent of the upper reaches of the catchment is in private ownership (Figure 4) and has been cleared for agricultural use. Table 1 shows the existing land uses for the catchment, the potential contamination risks from these and recommended protection strategies to reduce the contamination risk.

3.1.1 Water Corporation land

The Water Corporation owned Lot 21413 is mainly covered with native vegetation and secured by an internal fence line and gates that prevent access to the waterbody (see photo 3 Appendix B). However, several tracks still exist within this lot, which are illegally accessed for the collection of firewood and hunting (see photos 4 and 5 Appendix B). There is also evidence of swimming in the reservoir. Swimming (and other forms of direct body contact with the water) poses an unacceptable risk by introducing pathogens into the water resource and should not occur in the reservoir. Water birds and ducks are also active on the reservoir.

It should be noted that Lot 21413 is private freehold land owned by the Water Corporation. As such any access to this land (such as for hunting, swimming, fishing or other recreational pursuit) can be subject to Western Australian trespass laws as a control measure.

Access to Lot 21413 is relatively easy as a result of insufficient external fencing surrounding the lot and the presence of multiple tracks and access points. Access to Brookton Reservoir itself and Wabbing Hill Water Transfer Station is somewhat restricted by internal fences and gates, and good natural vegetation buffers around the reservoir reduce the threat to water quality.

3.1.2 Private land

The cleared private land is used for low intensity broadacre farming including grazing and cropping. These land uses are generally considered to be a medium pathogen risk to the quality of water within this source. These land practices are separated from the reservoir by the forested land on Lot 21413 and the activity levels on the grazing and cropping land is low. Use of best management practices is the recommended approach to ensure there is no increased risk of pollution, and local council land planning controls should support this approach.

3.1.3 Other land uses

There is a small amount of Crown land within the catchment set aside as road reserves. The catchment is dissected to the south by a minor road used for servicing the local farming community. Any spill of fuel or chemical that may result from an accident on this road is unlikely to have an impact on catchment water quality because of the vegetation buffers to the reservoir. Although the likelihood is low, a well prepared and widely distributed emergency response plan (WESTPLAN HAZMAT) needs to be put in place under the responsibility of the regional emergency management district.

3.2 Proposed land uses

There are no plans to alter or intensify existing land uses in the BRCA. Any development proposals within the BRCA that are likely to impact on water quality and/or quantity or are inconsistent with the department's water quality protection note *Land use compatibility in public drinking water source areas* or the Western Australian Planning Commission's *Statement of Planning Policy 2.7– Public drinking water source policy* should be referred to the department for advice and recommendations.

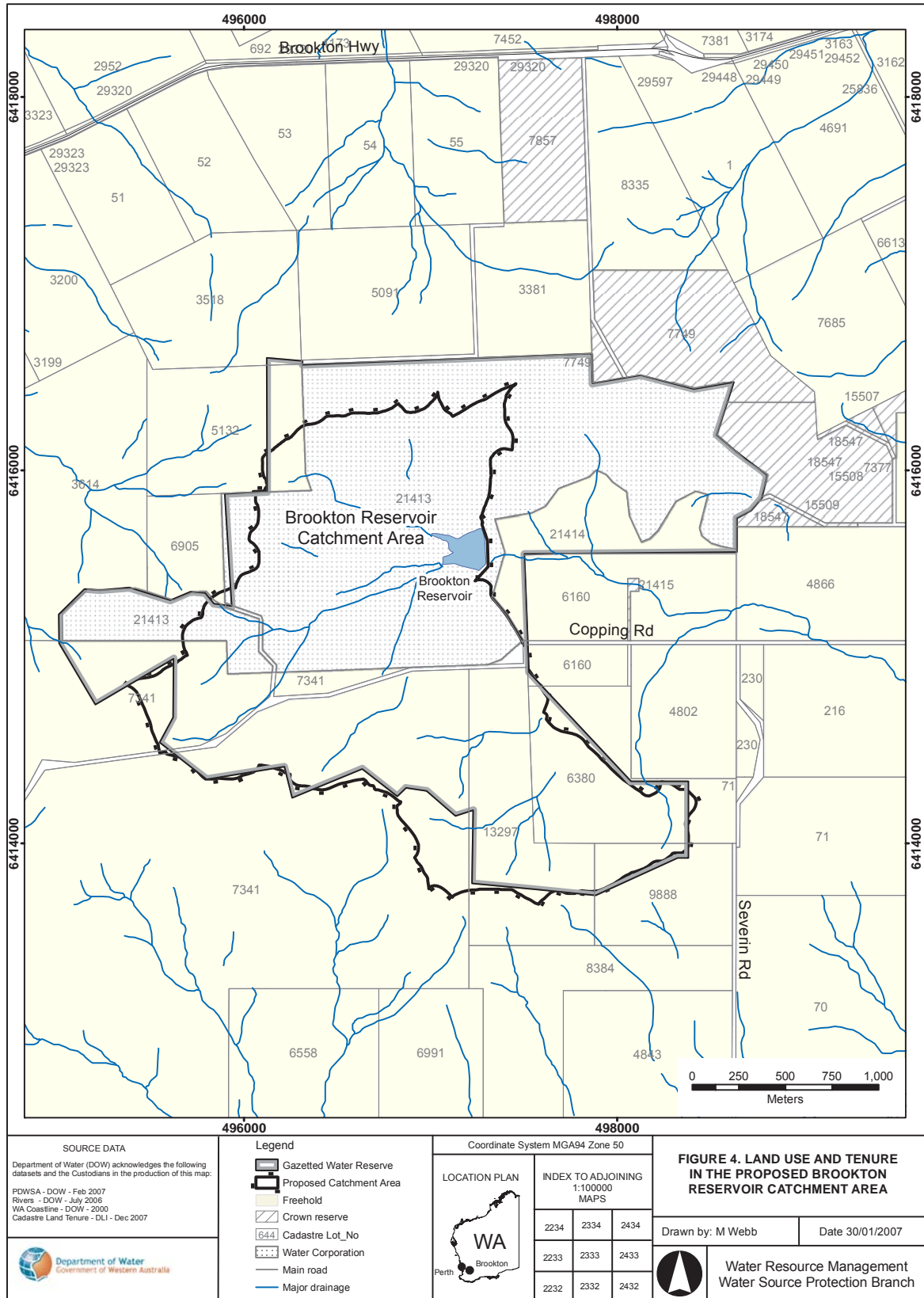


Figure 4 Land use and tenure in the proposed Brookton Reservoir catchment area

Table 1 Land use, potential water quality risks and recommended protection strategies

Land use / activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Water Corporation land					
Hunting	<ul style="list-style-type: none"> • Pathogen contamination from animal carcasses; • Pathogen contamination from people and dog faeces in the catchment. • Hydrocarbons from vehicles used for hunting. • Turbidity associated with unauthorised vehicle access in catchment. 	<p>Medium</p> <p>Medium</p> <p>Low</p> <p>Low</p>	<p>The application of <i>Country Areas Water Supply Act (1947)</i> by-laws.</p> <p>Hunting poses a serious risk to water quality and Water Corporation employee safety.</p>	<ul style="list-style-type: none"> • Existing fence directly surrounding the reservoir reduces access to the water source. • Existing signage notifying that hunting and fishing is prohibited and carries a fine. • Surveillance by Water Corporation Rangers currently reduces the occurrence of illegal hunting. • Water quality monitoring 	<ul style="list-style-type: none"> • Revise the location of existing signs, to ensure they are clearly visible and explain that hunting and dogs are prohibited on Water Corporation owned land. Signs should also indicate that this is private land and trespass laws apply. • Increase surveillance of the catchment and enforcement of CAWS Act by-laws.

Land use / activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Swimming	<ul style="list-style-type: none"> Pathogens from direct human contact with the water. Pathogens and nutrients from associated activities such as picnicking and bringing domestic animals into the catchment. 	<p>High</p> <p>Medium</p>	<p>Human or animal contact with water poses an immediate threat to water quality as all catchment protection barriers are broken.</p> <p>The reservoir is fenced but occasionally vandalised providing access to the reservoir.</p>	<ul style="list-style-type: none"> Signs exist to notify the public that swimming is prohibited in the reservoir Water quality monitoring 	<ul style="list-style-type: none"> Upgrade and repair the perimeter fence surrounding Lot 21413. Close and barricade access points to internal tracks that provide access to the reservoir protection zone. Update and increase the number of signs and promotional material to ensure the public are aware that swimming is prohibited in the reservoir. Signs should also indicate that this is private land and trespass laws apply. Undertake after-hours surveillance with by-law enforcement.

Land use / activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Firewood collection	<ul style="list-style-type: none"> Pathogen contamination through the presence of people and domestic animals near the reservoir or tributary. 	Medium	<p>The primary concern is the potential for people to be close to the reservoir or tributaries during public firewood collection.</p>	<ul style="list-style-type: none"> Internal fencing and gates surrounding the reservoir. Water quality monitoring. 	<ul style="list-style-type: none"> Ensure regional plans for public firewood collection areas give consideration to water quality protection objectives. Use signs and brochures to promote water catchment awareness and protection. Signs should also indicate that this is private land and trespass laws apply. Catchment rangers to facilitate water quality protection awareness during surveillance activities. Use signs and advertising material to ensure the public are aware that dogs are prohibited on Water Corporation owned land.
	<ul style="list-style-type: none"> Hydrocarbons associated with fuels and chain lubricants. 	Low	<p>The collection of firewood is only permitted in designated public firewood areas. There are no designated firewood collection points within the catchment. All firewood collection in the catchment is illegal.</p>		
	<ul style="list-style-type: none"> Rubbish dumping. 	Low	<p>Rubbish dumping is often associated with firewood collection.</p>		
	<ul style="list-style-type: none"> Turbidity from use of unsealed roads and damage to vegetation during off-road driving. 	Low	<p>Domestic animals often accompany people during firewood collection.</p>		

Land use / activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Fishing and yabbing	<ul style="list-style-type: none"> Pathogens from direct human, animal and bait contact with the water body. 	High	Human and animal contact can contaminate the water with pathogens.	<ul style="list-style-type: none"> Signage notifying people it is prohibited to fish in the reservoir. Fencing and gates limit access to the water body. Regular visits by Water Corporation rangers and staff. Water quality monitoring. 	<p><i>Fishing and yabbing are prohibited in the reservoir.</i></p> <ul style="list-style-type: none"> Use signs and advertising material to ensure the public are aware that fishing and yabbing are not permitted. Continue to undertake after-hours surveillance of the catchment with by-law enforcement, to deter offenders. Use signs and advertising material to ensure the public are aware that dogs are prohibited on Water Corporation owned land
	<ul style="list-style-type: none"> Turbidity from vehicle use close to the reservoir and tributaries. 	Low	There are additional risks associated with fishing and yabbing through on-site camping, the presence of dogs close to or in the reservoir or tributaries, and the use of baits.		

Land use / activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Camping and picnicking.	<ul style="list-style-type: none"> Pathogen contamination from people and animal faeces, human and animal direct bodily contact with the water. Nutrients and turbidity from uncontrolled access, unsealed tracks and illegal rubbish disposal. Hydrocarbons associated with vehicle access. 	<p>High</p> <p>Low</p> <p>Low</p>	<p>Camping in catchment areas (ie. wild camping) is generally prohibited to designated areas under <i>Country Areas Water Supply Act (1947)</i> there are no designated areas on Lot 21413.</p> <p>Camping poses a significant risk to water quality as appropriate facilities are not available and sites people choose to camp are generally close to the reservoir or tributaries.</p> <p>Camping maybe associated with other prohibited activities such as fishing and hunting and lighting camp fires.</p>	<ul style="list-style-type: none"> Camping is prohibited. Signage notifying public that it is illegal to camp and offenders may be prosecuted. Internal fencing limiting access to the reservoir. 	<ul style="list-style-type: none"> Use signs and advertising material to ensure the public are aware that camping is prohibited on Water Corporation owned land, and to educate people on the importance of protecting drinking water quality. Undertake surveillance of the catchment with by-law enforcement.

Land use / activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Wildfires	<ul style="list-style-type: none"> Erosion and turbidity Carbon and nutrient contamination; An increase in pathogens and nutrients due to the loss of filtering vegetation and death of animals. 	<p>Low</p> <p>Low</p> <p>Medium</p>	<p>Intense wildfire can cause turbidity from airborne ash or runoff from fire fighting activities or rainfall, particularly from the lack of vegetation cover.</p> <p>Water Corporation (as the landowner) have responsibility for maintaining firebreaks.</p> <p>The lack of surrounding bushland outside of Lot 21413 should reduce the incidence of wildfire.</p> <p>Wildfires are not generally a regular (annual) occurrence in the BRCA.</p>	<ul style="list-style-type: none"> Internal tracks providing access to areas within Lot 21413 to fight fires. Fire management plan. 	<p><i>Water Corporation staff member to attend fires in the catchment area.</i></p> <ul style="list-style-type: none"> Where location, extent or intensity of a fire suggests the need, inspect sites following fire to assess the need for turbidity mitigation works and conduct any necessary works. To ensure water quality considerations are addressed, Water Corporation staff should continue to attend all fires in the catchment area. Water Corporation staff should continue to undertake catchment inspections and post fire water quality monitoring. Ensure sites that need permanent protection from wildfire have adequate fire control lines.

Land use / activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Private land use					
Broadacre farming <ul style="list-style-type: none"> • Cropping • Grazing 	<ul style="list-style-type: none"> • Pathogen and nutrient contamination from domestic wastewater disposal systems, stock grazing and access to streams. 	Medium	Private land in the catchment is zoned for general farming activities in the Shire of Brookton Town Planning Scheme.	<ul style="list-style-type: none"> • Water quality monitoring. • Land planning controls. • Partial fencing restricting access to the reservoir protection zone. • Native vegetation buffer around the reservoir protection zone. 	<i>Existing land uses are acceptable with best management practices.</i> <ul style="list-style-type: none"> • Encourage landowners to adopt best management practices. • Ensure compliance with vegetation clearing controls on affected private land. • Investigate opportunities to assist landowners with land care initiatives, such as streamline restoration, to improve water quality. • Refer development proposals within the BRCA that are likely to impact on water quality and/or quantity or are inconsistent with the department's water quality protection note <i>Land use compatibility in public drinking water source areas</i> or the
	<ul style="list-style-type: none"> • Nutrient and pesticide contamination from application to crops, and inappropriate storage and disposal of containers. 	Low	Low intensity activity in upper catchment, with the reservoir buffered by extensive natural bushland area on Water Corporation owned land.		
	<ul style="list-style-type: none"> • Hydrocarbon contamination through fuel spills from storage, refuelling, mechanical servicing and waste oil disposal. 	Low	Further intensification of cropping and grazing practices is considered undesirable from a water quality protection perspective. The Department of Water's Statewide Policy No.2 <i>Pesticide use in public drinking water source areas</i> should be considered when dealing with pesticide use and		

Land use / activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
			<p>storage.</p> <p>Properly maintained fencing around the reservoir protection zone restricts stock access and reduces the risk of contamination.</p>		<p>Western Australian Planning Commission's Statement of Planning Policy 2.7 <i>Public drinking water source policy</i> to the department for advice and recommendations.</p> <ul style="list-style-type: none"> • Ensure chemical storage and use complies with the water quality protection note <i>Toxic and hazardous substances – storage and use</i>. • Pesticide use should comply with Department of Water's Statewide Policy No.2 <i>Pesticide use in public drinking water source areas</i>

Land use / activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Crown Land (Road Reserves)					
Roads and tracks	<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 reservoir or tributaries. 	<p>Low</p> <p>Low</p> <p>Medium</p>	<p>Roads and tracks are necessary for service access between private properties.</p> <p>Copping Rd dissects the catchment and separates farm land from the reservoir protection zone.</p> <p>Copping Rd is used as a transport route for farm supplies including livestock, feed, chemicals and hydrocarbons.</p> <p>Control of access to the reservoir protection zone is a major issue in the catchment due to easy access from Copping Rd.</p>	<ul style="list-style-type: none"> • Water quality monitoring. • Existing vegetation buffer around reservoir. 	<p><i>It is necessary to allow access to private properties.</i></p> <ul style="list-style-type: none"> • Encourage adherence to the department's water quality protection note <i>Roads near sensitive water resources</i> • Ensure a WESTPLAN HAZMAT emergency response plan for the catchment is prepared. • Ensure an operative emergency response procedure exists and that the LEMC is aware of catchment boundaries. • Review access points to the reservoir protection zone, identify and close roads not essential for access. • Ensure road upgrades follow existing road alignments and incorporate measures to

Land use / activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
					<p>avoid or minimise water source contamination risks (ie. drainage away from catchment).</p> <ul style="list-style-type: none"> • Display the emergency contact number on signs for use in the event of a spill.

4 Catchment protection strategy

4.1 Protection objectives

The objective of water source protection is to preserve water quality at its current levels, and where practical, to achieve an improved protection of water quality for distribution to the Brookton town water supply.

The fundamental water quality objectives for the Brookton Reservoir catchment area (BRCA) are risk avoidance and risk minimisation. The water quality within the reservoir should be preserved by avoiding contamination risks to the water source from inappropriate land uses and activities.

The preparation of this DWSPP forms part of the multiple barrier approach for the protection of public drinking water sources from potential contamination. The objective of this plan is to manage activities in the BRCA to protect the primary value of raw water for public drinking water supply, while appropriately recognising approved and established land uses.

4.2 Proclaimed area

The Brookton Water Supply catchment area was proclaimed in 1959 under the *Country Areas Water Supply Act (1947)* to ensure protection of the water source from potential contamination. This DWSPP proposes to re-gazette the catchment area as the Brookton Reservoir catchment area and amend the existing boundary of the catchment area to reflect the surface water catchment flows based on hydrological modelling. This will allow the Department of Water to better manage potentially contaminating land uses and protect water quality.

An explanation of priority classifications and protection zones proposed for the BRCA and the land use compatibility associated with each priority classification is provided on the department's website at www.water.wa.gov.au > Water Quality > Publications > Water Quality Protection Notes > *Land use compatibility in public drinking water source areas*.

4.3 Protection classifications

Almost half of the land within the proposed Brookton Reservoir catchment area is Water Corporation owned freehold land. This land should be managed for Priority 1 (P1) water source protection, with risk avoidance being the main management objective.

Surrounding land uses are dominated by broadacre farming practices. Cereal crops and sheep grazing are the dominant style of farming on private land within the catchment area. This land should be managed for Priority 2 (P2) water source protection, with the management objective being to minimise risks associated with

the land uses that may compromise the quality of water within the Brookton Reservoir. The proposed priority classification areas are shown in Figure 5.

To preserve the BRCA the plan proposes to:

- Amend the currently gazetted catchment boundary of the Brookton Water Supply catchment area to more accurately reflect the catchment area based on new hydrological modelling.
- Manage Lot 21413 for P1 source protection to protect the quality of water within the catchment area (see Figure 5).
- Manage private farm land for P2 source protection by employing best management practices to enhance the quality of water leaving private land (see Figure 5).

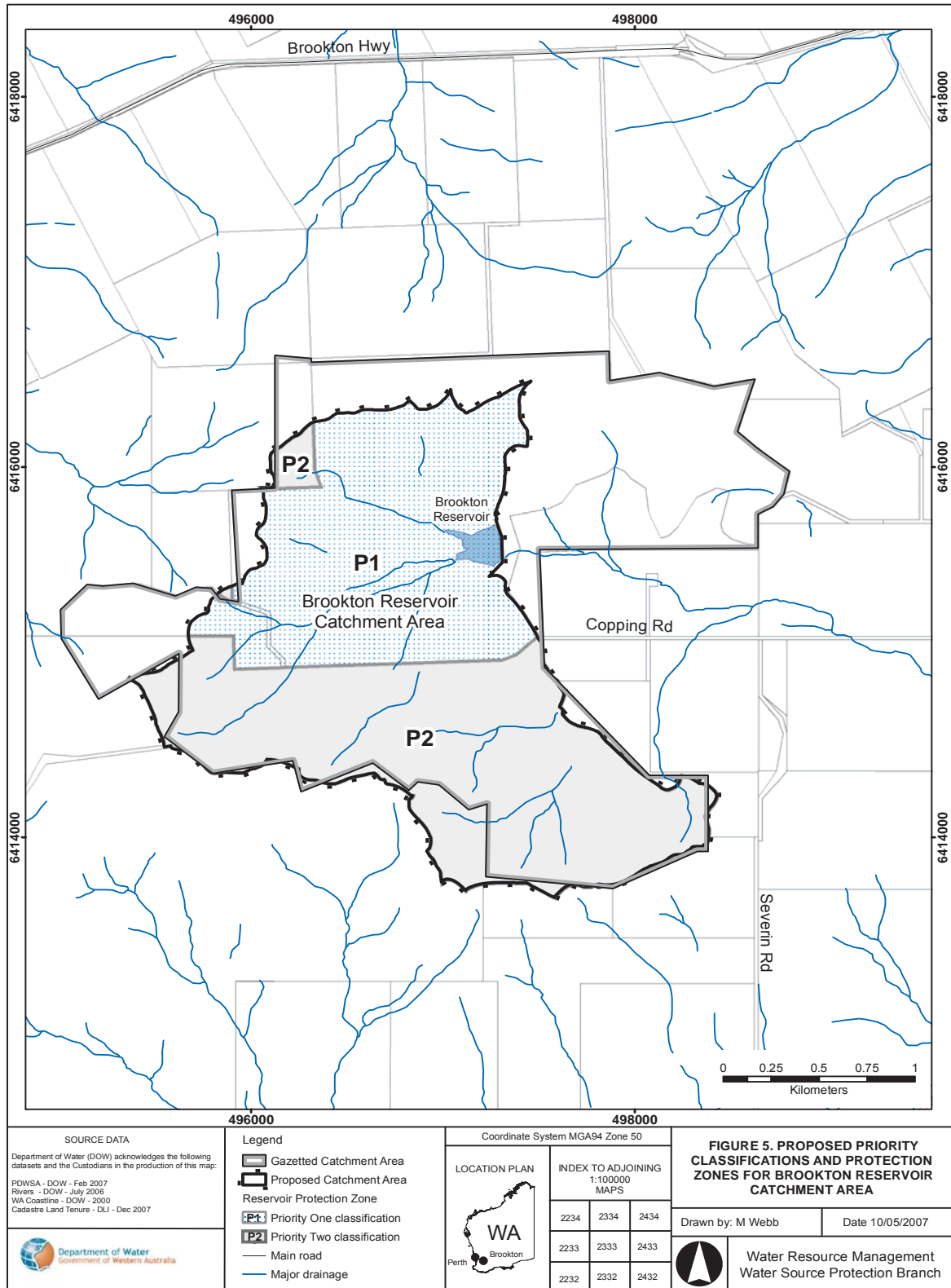
4.4 Protection zones

To protect the reservoir from immediate risks to water quality such as human and animal contact, it is recommended that the catchment be managed with a reservoir protection zone (also known as an prohibited zone) surrounding the reservoir. This is a key barrier in the approach to protecting reservoir and drinking water quality.

An reservoir protection zone is usually defined by a two kilometre buffer area around the top water level of the reservoir, including the reservoir itself, and does not extend outside the catchment area. However, in this instance it is proposed to establish the reservoir protection zone on Water Corporation owned freehold land Avon Location, Lot 21413 and not extend the reservoir protection zone the full 2 kilometres from the high water mark of the reservoir (Figure 5).

The quality and extent of vegetation buffers directly surrounding the reservoir is considered to provide adequate protection for this source from the risks associated with broadacre farming on surrounding private land. Therefore, the reservoir protection zone will only be applied to Water Corporation owned land. Within this zone, by-laws made under CAWS Act prohibit and restrict land use and human activities to prevent water source contamination.

The development of organised events within the reservoir protection zone is generally opposed. This is freehold land and public access to the area would generally be prohibited in accordance with Water and Rivers Commission *Statewide policy No. 13 – Policy and guidelines for recreation within public drinking water source areas* (2003). This policy is subject to review during 2008–09. Existing legal activities within this zone will be audited for compliance with water quality protection objectives.



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Figure 5 Proposed priority classifications and protection zones for Brookton Reservoir catchment area

4.5 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 necessary to secure the long-term protection of drinking water sources. As outlined in *Statement of Planning Policy 2.7 Public drinking water source policy* (Western Australian Planning Commission 2003) it is appropriate that the BRCA, the reservoir protection zone and priority classifications be recognised in the Shire of Brookton Town Planning Scheme. Any development proposals within the BRCA that are inconsistent with the Department of Water's, water quality protection note – *Land use compatibility in public drinking water source areas* should be referred to the Department of Water.

The department's protection strategy for PDWSA provides for lawfully established and operated developments to continue despite their location or facilities posing a level of risk to water quality which would not be accepted for new developments. The department may negotiate with landowners/operators on measures to improve these facilities or processes to lessen the level of water contamination risk.

In critical areas close to water sources, the department may make an offer to purchase land or development rights where the level of contamination risk is considered significant enough to have the potential to compromise the quality of water resources.

4.6 Best management practices

There are opportunities to significantly reduce risks to water quality by carefully considering design and management practices. The adoption of best management practices for land uses will continue to be encouraged to help protect water quality. On freehold land, the Department of Water aims to work with landowners to achieve best management practices for water quality protection through the provision of management advice.

There is currently funding available for farmers wishing to gain assistance with fencing off watercourses through the "Fence the Avon Project" funded by the Avon Catchment Council (ACC) and the Department of Water. Materials are allocated to farmers based on a priority system to encourage projects that will provide the most benefit to the environment, economy and the community. Availability of fencing materials in the future is subject to ongoing funding. For further details on this and other relevant ACC projects please contact the Department of Water, Northam Office, 08 9690 2600 or ACC 08 9690 2250.

There are guidelines available for many land uses in the form of industry codes of practice, environmental guidelines or water quality protection notes. These have been developed in consultation with stakeholders such as industry groups, producers, state government agencies and technical advisers. Examples include the

water quality protection notes *Toxic and hazardous substances – storage and use and Agriculture - dryland crops near sensitive water resources*, which are listed in the references section of this document. These guidelines help managers reduce the risk of their operations causing unacceptable water quality impacts. They are recommended as best practice for water quality protection.

Education and awareness (for example, signage and information material) is a key mechanism for water quality protection, especially for those people visiting the area who are unfamiliar with the BRCA. A brochure will be produced describing the BRCA, its location and the main threats to water quality protection. This brochure will be available to the community and will inform people in simple terms about the drinking water source and the need to protect it.

4.7 Surveillance and by-law enforcement

The quality of public drinking water sources within country areas of the state is protected under the *Country Areas Water Supply Act (1947)*. Declaration of public drinking water source areas allows existing by-laws to be applied to protect water quality.

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

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

4.8 Emergency response

Escape of chemicals during unforeseen incidents and use of chemicals during emergency responses can result in water contamination. The Shire of Brookton's Local Emergency Management Committee (LEMC) through the Wheatbelt Emergency Management District should be familiar with the location and purpose of the BRCA. A locality plan should be provided to the fire and rescue services headquarters for the Hazardous Materials (HAZMAT) Emergency Advisory Team. The Water Corporation should have an advisory role to any HAZMAT incident in the BRCA.

Personnel who deal with WESTPLAN HAZMAT (Western Australian Plan for Hazardous Materials) incidents within the area should have access to a map of the BRCA. These personnel should have adequate understanding of the potential impacts of spills on the water resource.

4.9 Implementation of this plan

Table 1 identifies the potential water quality risks associated with existing land uses in the BRCA and recommends protection strategies to minimise these risks.

Following publication of the final BRCA drinking water source protection plan, an implementation strategy will be drawn up based on the recommendations in Table 1. It will describe time frames and funding sources for the recommended protection strategies and identify responsible stakeholders. This is reflected in the recommendations section of this plan.

5 Recommendations

- 1 The proposed boundary of the Brookton Reservoir catchment area should be amended under the *Country Areas Water Supply Act 1947 (Department of Water)*.
- 2 Prepare an implementation strategy for the protection strategies discussed in Table 1: *Land use, potential water quality risks and recommended protection strategies* of this plan showing responsible stakeholders and planned time frames (*Department of Water in consultation with applicable stakeholders*).
- 3 The Shire of Brookton Town Planning Scheme should incorporate this plan and reflect the identified Brookton Reservoir catchment area boundary, the Priority 1 and 2 classifications, and reservoir protection zone (*Shire of Brookton*).
- 4 All development proposals within the Brookton Reservoir catchment area that are likely to impact on water quality and/or quantity, or are inconsistent with the *water quality protection note – Land use compatibility in public drinking water source areas* or *Statement of planning policy No.2.7 – Public drinking water source policy* should be referred to the Department of Water for advice and recommendations (*Department for Planning and Infrastructure, Shire of Brookton, Department of Water, developers/landowners*).
- 5 Incidents covered by WESTPLAN HAZMAT in the Brookton Reservoir catchment area should be addressed by ensuring that:
 - the Shire of Brookton LEMC are familiar with the location and purpose of the Brookton Reservoir catchment area
 - the locality plan for the Brookton Reservoir catchment area is provided to the Fire and Rescue headquarters for the HAZMAT Emergency Advisory Team
 - the Water Corporation provides an advisory role during incidents in the Brookton Reservoir catchment area
 - personnel dealing with WESTPLAN HAZMAT incidents in the area have ready access to a locality map of the Brookton Reservoir catchment area and training to understand the potential impacts of spills on drinking water quality(*Department of Water, Water Corporation*)
- 6 The existing surveillance program should be maintained to identify any incompatible land uses or potential threats within the Brookton Reservoir catchment area (*Water Corporation*).
- 7 Signs located along the boundary of the Brookton Reservoir catchment area should be maintained to define the location and promote awareness of the need to protect drinking water quality. Signs should include an emergency contact telephone number. Signage should also be erected around the reservoir protection zone indicating that it is private land and trespass on this land poses a risk to water quality (*Water Corporation*).
- 8 Replace and upgrade perimeter fencing surrounding Water Corporation owned land Lot 21413 to prevent access to the reservoir and the reservoir protection zone (*Water Corporation*).

- 9 Internal fences surrounding the reservoir should be maintained and upgraded to prevent stray stock, swimmers, campers and hunters accessing the water body (*Water Corporation*).
- 10 Tracks used by the public to access Lot 21413 should be closed or access restricted to prevent unauthorised access within the reservoir protection zone. A review should be carried out to determine what tracks are not required for water supply or fire management purposes and any tracks not required for these functions should be closed and rehabilitated (*Water Corporation*).
- 11 The elevated microbiological counts in the water samples taken from Brookton Reservoir should be further investigated with attempts to determine and remove the source (*Water Corporation*).
- 12 A review of this plan should be undertaken within five years (*Department of Water*).

Appendices

Appendix A - Water quality

The Water Corporation has monitored the raw (source) water quality from Brookton Dam in accordance with the *Australian Drinking Water Guidelines 2004* (ADWG) and interpretations agreed to with the Department of Health. The raw water is regularly monitored for:

a. Aesthetic related characteristics – (Non-Health Related)

b. Health related characteristics

- Health Related Chemicals
- Microbiological Contaminants

Following is data representative of the quality of raw water in Brookton Dam. In the absence of specific guidelines for raw water quality, the results have been compared with ADWG values set for drinking water, which defines the quality requirements at the customers tap. Results that exceed ADWG have been highlighted to give an indication of potential raw water quality issues associated with this source.

It is important to appreciate that the raw water data presented does not represent the quality of drinking water distributed to the public. Barriers such as storage and water treatment, to name a few, exist downstream of the raw water to ensure it meets the requirements of ADWG. For more information on the quality of drinking water supplied to Brookton refer to the most recent Water Corporation Drinking Water Quality Annual Report at http://www.watercorporation.com.au/W/waterquality_annualreport.cfm?uid=2377-9937-9579-7091.

Aesthetic Related Characteristics

Aesthetic water quality analyses for raw water from Brookton Dam are summarised in Table 1.

The values are taken from ongoing monitoring for the period February 2003 to February 2008. All values are in milligrams per litre (mg/L) unless stated otherwise. Any water quality parameters that have been detected are reported, those that have on occasion exceeded the ADWG are highlighted.

Table 1 Aesthetic related detections for Brookton Dam

Parameter	Units	ADWG Aesthetic Guideline Value*	Brookton Dam	
			Range	Median
Aluminium unfiltered	mg/L	NA	<0.008 - 0.47	0.0775
Chloride	mg/L	250	210 - 255	235
Colour - True	TCU	15	<1 - 11	5
Conductivity at 25°C	mS/m	NA	43 - 120	92
Hardness as CaCO ₃	mg/L	200	92 - 119	101
Iron unfiltered	mg/L	0.3	<0.003 - 0.44	0.07
Manganese unfiltered	mg/L	0.1	<0.002 - 0.038	0.006
pH	NO UNIT	6.5 - 8.5	6.15 - 9.21	7.73
Sodium	mg/L	180	120 - 160	130
Sulphate	mg/L	250	14 - 20	15
TFSS	mg/L	500	446 - 542	479
Turbidity	NTU	5	0.4 - 8.4	1.8

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

Health Related Characteristics

Health Parameters

Raw water from Brookton Dam is analysed for health related chemicals including inorganics, heavy metals, industrial hydrocarbons and pesticides. Health related water quality parameters that have been measured at detectable levels in the source between February 2003 and February 2008 are summarised in Table 2. Fluoride levels in Brookton Reservoir are influenced by GSTWS water, which is fluoridated at Harris Dam. Any parameters that have on occasion exceeded the ADWG are highlighted.

Table 2 Health related detections for Brookton Dam

Parameter	Units	ADWG Health Guideline Value*	Brookton Dam	
			Range	Median
Barium [†]	mg/L	0.7	0.02	0.02
Boron [†]	mg/L	4	0.05	0.05
Fluoride	mg/L	1.5	0.45 - 0.85	0.7
Nitrate as nitrogen	mg/L	11.29	0.055 - 0.27	0.155
Nitrite as nitrogen	mg/L	0.91	0.004 - 0.008	0.005
Nitrite plus nitrate as N	mg/L	11.29	0.07 - 0.29	0.12

* 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.

[†] Water quality data observed from 3 or less sampling occasions.

Microbiological Contaminants

Microbiological testing of raw water samples from Brookton Dam is currently conducted on a weekly basis. *Escherichia coli* counts are used as an indicator of the degree of recent faecal contamination of the raw water from warm-blooded animals. A count less than 20 most probable number (MPN) per 100 mL is typically associated with low levels of faecal contamination and is used as a microbiological contamination benchmark of the raw water (World Health Organisation 2006). As such, counts less than 20 MPN are seen as being an indication of raw water that has not been recently contaminated with faecal material.

During the reviewed period of February 2003 to February 2008, positive *Escherichia coli* counts were recorded in 92% of samples. Approximately 57% of these samples had *Escherichia coli* counts greater than 20 MPN/100mL.

Brookton Dam is considered a high risk source due to illegal recreation and the presence of waterbirds and natural fauna. Operational strategies are in place to reduce this risk.

Appendix B - Photographs



Photo 1 Brookton Reservoir



Photo 2 Sedges around Brookton Reservoir



Photo 3 Internal fence and tracks on Lot 21413 (fence has been cut)



Photo 4 Kangaroo carcass



Photo 5 Sign damaged by hunters

Glossary

ADWG	The <i>Australian Drinking Water Guidelines</i> , outlining guideline criteria for the quality of drinking water in Australia.
Aesthetic guideline	NHMRC guideline level ascribed to acceptable aesthetic qualities of drinking water such as taste, smell, colour and temperature.
AHD	Australian Height Datum is the height of land in metres above mean sea level. For example this is +0.026 m at Fremantle.
ANZECC	Australian and New Zealand Environment Conservation Council
ARI	Average Recurrence Interval is a statistical measure of the average period (in years) between two separate occurrences of an event (for example, flood or rainfall).
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
Augment	To increase the available water within a storage Reservoir by pumping back water from a secondary storage/reservoir.
Catchment	The area of land which intercepts rainfall and contributes the collected water to surface water (streams, rivers, wetlands) or groundwater.
CFU	Coliform forming units is a measure of pathogen contamination in water.
Effluent	The liquid, solid or gaseous wastes discharged by a process, treated or untreated.
GL	Gigalitres (1000 000 000 litres)
GSTWS	Great Southern Town Water Supply
ha	Hectares (a measure of area)
kL	Kilolitres (1000 litres)
km	Kilometres (1000 metres)
km²	Square kilometres (a measure of area)

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	Metres
mg/L	Milligrams per litre (0.001 grams per litre)
ML	Megalitres (1 000 000 litres)
mm	Millimetres
NHMRC	National Health and Medical Research Council
NRMCC	Natural Resource Management Ministerial Council
NTU	Nephelometric turbidity units are a measure of turbidity in water.
Nutrient load	The amount of nutrient reaching the waterway over a given timeframe (usually per year) from its catchment area.
Nutrients	Minerals dissolved in water, particularly inorganic compounds of nitrogen (nitrate and ammonia) and phosphorous (phosphate) which provide nutrition (food) for plant growth. Total nutrient levels include the inorganic forms of an element plus any bound in organic molecules.
Pesticides	Collective name for a variety of insecticides, fungicides, herbicides, algicides, fumigants and rodenticides used to kill organisms.
Point source pollution	Pollution originating from a specific localised source, for example, 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.
Public Drinking Water Source Area (PDWSA)	Includes all underground water pollution control areas, catchment areas and water reserves constituted under the <i>Metropolitan Water Supply Sewerage and Drainage Act 1909</i> and the <i>Country Areas Water Supply Act (1947)</i> .
Reservoir	A reservoir, tank, pond or lake that forms part of any public water supply works.

Run-off	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.
TDS	Total dissolved solids, a measurement of ions in solution, such as salts in water.
Treatment	Application of techniques such as settlement, filtration and chlorination to render water suitable for specific purposes including drinking and discharge to the environment.
Water quality	The physical, chemical and biological measures of water.

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