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

Menzies Water Reserve

Drinking water source protection plan

Menzies town water supply

Looking after all our water needs

Water resource protection series
Report WRP 114
May 2010

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Cover photograph: Menzies Town Hall (Photo: V. Claughton)

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Preface

How do we protect public drinking water source areas?

The Australian drinking water guidelines (ADWG) (NHMRC & NRMMC 2004a) outlines how we should protect drinking water in Australia. The ADWG recommends a 'catchment to consumer' framework that uses a risk-based, multiple-barrier approach. A similar approach is recommended by the World Health Organization in other countries worldwide.

The 'catchment to consumer' framework applies across the entire drinking water supply system, from the water source to the tap. It ensures a holistic assessment of risks to drinking water to maximise the delivery of safe drinking water to consumers.

A risk-based approach means that we look at all the different risks to water quality, and how to address them. A multiple-barrier approach means that we use different barriers against contamination at different stages of a drinking water supply system. The first barrier is protecting the catchment (the whole area from which water flows into the drinking water source). This plan helps to do that. Other barriers against contamination include:

- storage of water to help settle out contaminants
- treating the water (e.g. chlorination) to remove contamination
- maintenance of pipes
- monitoring of water quality.

As water treatment practices evolve, many people think that we no longer need to protect the catchment because we can 'engineer out the risks'. Nothing could be further from the truth (Krogh et. al 2008). Recent research and experience shows that a combination of catchment protection and water treatment is safer than relying on either barrier on its own. That's why this drinking water source protection plan is important. It's about protecting the catchment's water quality now and in the future.

In Western Australia, the Department of Water protects public drinking water source areas (PDWSAs) by using the law; putting the ADWG into practice; writing plans, policies and guidelines; and providing input into land-use planning.

The *Metropolitan Water Supply Sewerage and Drainage Act 1909* (WA) and the *Country Areas Water Supply Act 1947* (WA) allow us to protect water. We proclaim PDWSAs under one of these Acts so that we can apply the legislation to protect water quality.

The ADWG outlines 12 elements to protect drinking water. We implement element two (assessment of the drinking water supply system) and element three (preventative measures for drinking water quality management) by writing drinking

water source protection plans. Plans have been, or are being written for all PDWSAs around the state. They give an overview of a drinking water source and outline the risks to water quality and how to address them. Our regional offices work with the community, other government agencies and landowners to put the recommendations into practice.

We also define special areas within PDWSAs: priority areas and protection zones. There are three different priority areas, each assigned a certain level of risk to water quality. Protection zones surround drinking water extraction points, so that the most vulnerable areas may be protected from contamination. Under legislation, some activities are restricted in protection zones.

If you would like more information about how we protect drinking water in Western Australia, go to <http://drinkingwater.water.wa.gov.au>.

The following table outlines the stages involved in the preparation of this drinking water source protection plan:

Stages in development of a plan		**Comment**
1	Prepare drinking water source protection assessment document. (December 2004)	Prepared after initial catchment survey and preliminary information gathering. This document may not be required if a drinking water source protection plan already exists or alternative documents provide suitable information.
2	Conduct stakeholder consultation. (February-April 2010)	Advice sought from key stakeholders using the assessment document as a tool for information and discussion.
3	**Publish approved drinking water source protection plan. (May 2010)**	**Final protection plan published after considering submissions. Includes recommendations on how to protect water quality. Proclamation of this public drinking water source area can now occur.**

Summary

This drinking water source protection plan aims to protect the quality of drinking water in the Menzies Water Reserve for public supply and, where practical, achieve water quality improvements. This will be achieved through identifying potential water quality contamination risks associated with land-use practices in this water reserve and implementing strategies to avoid, minimise or manage those risks.

The town of Menzies is located in the Goldfields region of Western Australia, 133 km north-northwest of Kalgoorlie and 728 km east-northeast of Perth. The town is adjacent to the Goldfields Highway and is the administrative centre for the Shire of Menzies.

Menzies receives its water supply from a Water Corporation wellfield located approximately 5 km east of Menzies. The wellfield draws water from a shallow fractured rock aquifer. The bores are screened at varying depths ranging from 14 to 61 m. The shallow, unconfined nature of the aquifer makes it vulnerable to contamination. The Water Corporation undertakes regular water quality monitoring and surveillance of the wellfield.

Menzies also has a surface water source, Menzies Town Dam No. 1. This dam is not currently used as a drinking water source; however, it will be retained within the water reserve because it may be used to supplement drinking water supply in the future (although this would require the installation of additional suitable water treatment systems). The Water Corporation is currently using the dam to store backwash from the Menzies water treatment plant.

In 2004, the Water Corporation completed a drinking water source protection assessment of the Menzies Water Reserve. This drinking water source protection plan has considered that assessment and, if implemented, will amend the boundary of the Menzies Water Reserve and establish appropriate priority areas and protection zones within it.

The existing water reserve was proclaimed in 1986 under the *Country Areas Water Supply Act 1947* (WA) and is proposed to be amended to exclude the Menzies town site. This will result in the water reserve's size being reduced and prevent conflict with any proposed developments of the town site.

Most of the water reserve's eastern half is covered by a pastoral lease with a few small areas of Crown reserve. The water reserve's western half is a mix of Crown reserve and unallocated Crown land. The area under pastoral lease has been identified as a Priority 2 area, while the remaining areas of Crown land have been identified as Priority 1 areas. The production bores are located in the water reserve's eastern half and have all been assigned 300 m wellhead protection zones.

The following actions are recommended to protect water quality within the Menzies Water Reserve:

- implementation of the protection strategies detailed in Table 1 of this drinking water source protection plan
- amendment of the existing Menzies Water Reserve boundary under the *Country Areas Water Supply Act 1947* (WA)
- preparation of an implementation strategy for this plan to determine agreed timeframes and stakeholder responsibilities for recommended protection strategies
- incorporation of this drinking water source protection plan into the Menzies town planning scheme and adoption of the amended Menzies Water Reserve (including its priority areas and protection zones) as a special control area
- enhancement of the Water Corporation's surveillance program to identify any incompatible land uses or potential water quality contamination threats within the Menzies Water Reserve
- installation of signs along the boundary of the water reserve to define the location and promote awareness of the need to protect drinking water quality.

This plan has been developed with input from the Water Corporation and the Shire of Menzies, and in consultation with landowners in the water reserve and relevant state government departments.

1 Drinking water source overview

1.1 Existing water supply system

The Menzies wellfield is operated by the Water Corporation and consists of five production bores (15/86, 22/86, 33/86, 1/99 and 2/99).The wellfield was first established over 70 years ago, however the bores currently in use were drilled in 1986 and 1999.

The wellfield draws water from a shallow fractured rock aquifer. The bores are screened at varying depths between 14 and 61 m below ground level, with a static water level ranging between 15 and 22 m. Bore 15/86 draws water from fractured schist and basalt. Bores 22/86 and 33/86 draw water from fractured basalts, while bores 1/99 and 2/99 draw water from within felsic volcanic units (Rockwater 1999). The location of the Menzies wellfield is shown in Figure A1 and the locations of the production bores within the water reserve are shown in Figure A2.

The Water Corporation undertakes regular water quality monitoring of the bore water and conducts surveillance of the production bores, water treatment plant and areas within the water reserve. Bore operation is controlled by 24-hour timers that are adjusted manually during regular visits by Water Corporation staff.

Raw water abstracted from the production bores is pumped to a water treatment plant adjacent to the Menzies Town Dam No.1, where it is treated before being pumped into a 200 kL storage tank on Harcourt Hill. Water is sometimes diverted to the Town Dam No.1 to avoid Harcourt Tank overflowing. The water is then supplied to the town reticulation system under gravity from Harcourt Tank. The locations of Harcourt Tank and the Town Dam No.1 are shown in Figure A4.

The Menzies Town Dam No.1 was constructed in 1905 and consists of an unroofed circular concrete excavated structure with a storage volume of 13 600 kL (Water Corporation 1999). The dam is not currently used to supplement drinking water supply. The estimated yield for the dam is 2100 kL/year with 80 per cent reliability (Andrews 1995).

Even though the dam is not being used as a drinking water supply source, it needs to be included in the water reserve because the Water Corporation use it to store backwash from the Menzies water treatment plant. It should also be managed for water quality protection because it may be used to supplement drinking water supply in the future (although this would require the installation of additional suitable water treatment systems).

1.2 Water treatment

The raw water pumped from the production bores is first passed through an ion exchange media to remove arsenic. It is then dosed with Calgon to mitigate hardness levels and in turn prevent scaling. After that the water is chlorinated to provide a disinfection barrier against possible microbiological contamination and treated with aluminium sulfate and sodium hypochlorite to control turbidity and algae. The water is treated at the Menzies Town Dam No.1 site and then pumped to Harcourt Tank for holding and distribution.

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

1.3 Catchment details

1.3.1 Physiography

Menzies lies within the Norseman-Wiluna greenstone belt where it has been divided into two sections by the intrusion of a granite dome. These greenstone belts form low ridges and areas of elevation. Relief is low (<200 m AHD) with the highest points found around Mount Morley (541 m AHD), 45 km to the west of Menzies. Local peaks include Mount Owen and Mount Menzies. There is a north-trending chain of lakes and claypans south-west of Menzies which join up to Lake Ballard in the north. This system links with lakes Goongarrie and Marmion in the south-east to form part of the Yindarlgooda Palaeoriver. Away from the areas of greenstone, there are sand and loam-covered plateaus with breakaways underlain by siliceous and ferruginous duricrust over granitic rock (Wyche 2003).

1.3.2 Climate

Menzies experiences a semi-arid climate. Rainfall varies from year to year with the driest months typically from September to December. The average rainfall is 258 mm/year with most coming from summer cyclonic rains and isolated thunderstorms. The mean maximum temperature ranges from 17°C in July to 35°C in January, while the mean minimum temperature ranges from 5°C in July to 20°C in January.

1.3.3 Hydrology/hydrogeology

Hydrogeology

Precambrian basement rocks underlie the Menzies area and include basalts, quartz-mica schists, pyritic chert and conglomerate. The layered sedimentary and volcanic rocks are metamorphosed and intruded by granites of probable Archaean age. During Tertiary times, the rocks of the Menzies area underwent deep weathering to 60 m or more and in places the weathered material became silicified and lateritised to form extensive deposits of laterite (Davidson 1986).

Groundwater flow within the aquifer system of the Menzies area is via fractures in the weathered to fresh basement rocks. Recharge to the aquifer occurs from periodic direct rainfall infiltration on local areas of bedrock outcrop and from indirect infiltration within the local drainage system during periods of extensive rainfall (Water Corporation 2004).The unconfined nature of the aquifer makes it vulnerable to contamination.

Hydrology

Menzies Town Dam No.1 consists of a natural catchment that has been partially graded as a roaded catchment. The roaded area is currently in poor condition. Water inflow to the dam is irregular because runoff from the catchment is characterised by short duration high-intensity rainfall events.

1.4 Future water supply requirements

In 2007 the Water Corporation conducted a source review for Menzies and investigated development options. It appears that poor aquifer recharge over recent years and an over-reliance on bore 1/99 to provide much of the water supply has caused problems with meeting demand. The current projected abstraction up until 2017–18 is not expected to exceed current wellfield capacity. However in 2007, output was restricted to 15 000 kL, hence the investigation and development of additional drinking water sources became necessary.

In 2009, the Water Corporation contracted Rockwater P/L to undertake a drilling program to locate additional bores for the Menzies wellfield. This drilling program also included an investigation of the potential to develop a high-yielding saline water source suitable for desalinated water supply. Thirteen sites were drilled for the groundwater investigation. Rockwater subsequently reported that two sites had intersected sufficient fresh water and recommended they be completed as water source production bores. The Water Corporation is in the process of installing these two additional bores (these additional bores are within the Menzies Water Reserve).

It is also possible that Menzies Town Dam No.1 may need to be used to supplement the drinking water supply in the future, although this would require the installation of

additional suitable water treatment systems. The Water Corporation is currently using the dam to store backwash from the Menzies water treatment plant.

If Menzies experiences a drinking water supply emergency, the Water Corporation has a contingency plan to cart water from Kalgoorlie.

1.5 Existing drinking water source protection

Menzies Water Reserve was proclaimed in 1986 under the *Country Areas Water Supply Act 1947* (WA) for the purpose of public drinking water source protection. By-laws created under this Act enable the Department of Water to control potentially polluting activities, regulate land use, inspect premises and take the necessary steps to prevent or clean up pollution.

The Department of Water has delegated powers of monitoring and by-law enforcement to the Water Corporation for some public drinking water source areas (PDWSAs). For more information, please refer to Section 4.7: Surveillance and by-law enforcement.

The Water Corporation monitors bore water levels regularly. Monitoring of conductivity and temperature is conducted at least every three months, while monitoring and analysis of major raw water components is conducted annually. Recent water quality data is shown in Appendix B. The Water Corporation also conducts regular surveillance and inspections of the water treatment plant, bore compounds and other areas in the water reserve.

No priority areas or protection zones are currently assigned within the water reserve, although historically Crown land has been managed for Priority 1 source protection and pastoral land has been managed for Priority 2 source protection. The priority areas and wellhead protection zones were assigned during the development of this drinking water source protection plan and it is recommended they be implemented once this plan is published.

In 2004 the Water Corporation prepared the Menzies Water Reserve drinking water source protection assessment. This document outlined risks to water quality from land uses and activities in the Menzies Water Reserve. This drinking water source protection plan builds upon and replaces the drinking water source protection assessment.

The Menzies town planning scheme recognises the existing Menzies Water Reserve as a special control area (Special Control Area No. 5, Water Catchment). The types of development supported in this special control area are described in the Department of Water's Water quality protection note no. 25 (WQPN no. 25): *Land use compatibility in public drinking water source areas*.

The Menzies town planning scheme states that: 'No development shall occur within this area that may jeopardise the continued extraction of the groundwater resources to service the town's water supply' (Shire of Menzies 2002).

1.6 Department of Water management

1.6.1 Current allocation licence

Water resource use and conservation in Western Australia is administered by the Department of Water in accordance with the *Rights in Water and Irrigation Act 1914* (WA). Under this Act, the right to use and control surface water and groundwater is vested with the Crown. The Act requires licensing of surface water extraction (removing water from a waterway) within surface water areas proclaimed under the Act and groundwater abstraction (pumping water from a bore, spring or soak) within groundwater areas proclaimed under the Act and all artesian wells throughout the state.

Under groundwater well licence 102686, the Water Corporation is licensed to draw 29 000 kL/year from the Menzies wellfield for public water supply purposes. The Menzies wellfield is located within the Goldfields Groundwater Area.

Abstraction in 2007 was 14 918 kL, abstraction is usually higher but the wellfield was not used between June and October 2007 in an effort to improve aquifer storage. The average abstraction from 2004 to 2007 was 24 049 kL/year. Abstraction in 2005 was 29 836 kL/year.

In 2004 the number of services was 63; by 2008 the number of services had decreased to 60, which is also the estimated current number of services.

2 Water quality monitoring and contamination risks

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

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

A water quality summary for the Menzies wellfield from July 2004 to June 2009 is presented in Appendix B. For more information on water quality, see the Water Corporation's most recent drinking water quality annual report at <www.watercorporation.com.au> What we do > Water quality > Water quality publications > Water quality annual report 2008–09.

It should be noted that testing is conducted on raw water, and that all ADWG limits – apart from nitrate – are met following treatment before supply to consumers. Nitrate is a naturally occurring substance in the groundwater of the Menzies region.

The Department of Health has granted this scheme an exemption from compliance with the ADWG for nitrate. The water supplied is harmless to adults and children over three months of age. Carers of infants younger than three months should seek advice from their community health nurse regarding the use of alternative water sources for the preparation of bottle feeds. The Water Corporation provides bottled water free of charge via the community health nurse for this purpose, as required. The Water Corporation has committed to improving the quality of water supply for Menzies.

Contamination risks relevant to drinking water sources are described below.

2.1 Microbiological

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

A number of pathogens are commonly known to contaminate water supplies worldwide. These include bacteria (e.g. salmonella, *Escherichia coli* and cholera),

protozoa (e.g. *Cryptosporidium*, *Giardia*) and viruses. *E. coli* counts are a way to measure these pathogens and provide an indication of faecal contamination.

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

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

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

When people consume drinking water contaminated with pathogens the effects vary considerably, ranging from mild illness (such as stomach upset or diarrhoea) to hospitalisation and sometimes even death. During 2000, seven people died in Walkerton, Canada, because the town water source and supply was contaminated by a pathogenic strain of *E. coli* and campylobacter (NHMRC & NRMMC 2004b). Where possible, avoiding the introduction of pathogens into a water source is the most effective way to protect public health.

2.2 Health related

Land- and water-based uses and activities within a catchment can directly affect water quality and treatment. For example, off-road driving contributes to erosion and the uprooting of vegetation which can increase turbidity in water. This increased turbidity can subsequently reduce the effectiveness of treatment processes (such as disinfection).

Erosion results in the mobilisation of soil particles that are released into the air and tributaries, increasing the turbidity of the main water body. Pathogens can absorb onto these soil particles and may be shielded from the effects of disinfection. Increased turbidity also impacts on other environmental constituents: it smothers riparian vegetation and reduces the transfer of light within the water column, which in turn affects plant growth.

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

Pesticides include agricultural chemicals such as insecticides, herbicides, nematicides (used to control worms), rodenticides and miticides (used to control mites). Contamination of a drinking water source by pesticides (and other chemicals) may occur as a result of accidental spills, incorrect use or leakage from storage areas. In such cases, the relevant authorities should be notified promptly and the spill cleaned up.

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

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

2.3 Aesthetic

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

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

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

2.4 Groundwater bores

The Menzies Water Reserve is located within the Goldfields Groundwater Area, which is proclaimed under the *Rights in Water and Irrigation Act 1914* (WA). Under the provisions of sections 26D and 5C of the Act, a licence is required to construct a bore or abstract water within a proclaimed groundwater area (unless exempt under the Rights in Water and Irrigation Exemption and Repeal [Section 26C] Order 2001).

The Water Corporation operates drinking water bores in the Menzies Water Reserve. If bores for other purposes (e.g. irrigation, private household use) are drilled near a public drinking water supply bore, they can cause contamination of the drinking water source. For example, a poorly constructed private bore may introduce contaminants from surface leakage down the outside of the bore casing into an otherwise uncontaminated aquifer.

It is therefore important to ensure that any bores are appropriately located and constructed to prevent contamination of the public drinking water source. This will be assessed through the Department of Water's water licensing process where applicable under the *Rights in Water and Irrigation Act 1914* (WA). All bores should be constructed in accordance with *Minimum construction requirements for water bores in Australia* (National Minimum Bore Specifications Committee 2003).

3 Land-use assessment

3.1 Existing land uses and activities

The Menzies Water Reserve is located over a mixture of Crown land and Crown lease. Most of the water reserve's eastern half is covered by a pastoral lease with a few small areas of Crown reserve. The water reserve's western half is a mix of Crown reserve and unallocated Crown land. Refer to Figure A3 for a map showing the areas of Crown land and pastoral lease.

Pastoral activity in the water reserve is currently low. There are a number of mining and prospecting leases near the wellfield recharge area, however activity in these areas is currently minimal, with no active mines. Two disused open-pit gold mines (Granny Venn and Good Enough) are located north of Mount Menzies, outside of the wellfield recharge area. A number of additional abandoned mine shafts and wells also exist within the water reserve.

Current land uses and activities are outlined below. This information has been summarised in Table 1 at the end of this section. This table also identifies the recommended management priorities for different hazards. Refer to Figure A3 and Figure A4 for the location of some of the current land uses and activities within the Menzies Water Reserve. Appendix C of this plan uses data in Table 1 and this section to recommend protection strategies for key stakeholders to consider.

3.1.1 Pastoral lease

There is currently one pastoral lease (Jeedamya Station) in the Menzies Water Reserve. This lease covers the water reserve's eastern half. There is currently minimal activity on this pastoral lease, with no evidence observed of recent infrastructure construction and/or maintenance by the pastoralist within the water reserve. This pastoral lease may be left unused for a number of years because the pastoralist is currently losing a high number of livestock to wild dogs.

Livestock grazing can present a risk of nutrient and pathogen contamination to the water source. This risk is considered low in the Menzies Water Reserve given that stocking rates are very low and not expected to increase in the near future. Wild dogs can pose a nutrient and pathogen contamination risk to the water source, however their numbers are expected to decrease when all the stock grazed on the pastoral lease is removed.

Roads and tracks

A number of unsealed tracks exist within the pastoral lease. These tracks pose a risk to the water reserve by providing access to the production bores. Vandalism of the production bores or theft of diesel from the storage tanks can result in hydrocarbon contamination of the water source from spills or leaks. An increased number of

vehicles within the water reserve also poses a hydrocarbon contamination risk to the water source from leaks, spills or vehicle accidents. This risk can be reduced by ensuring that all unused bores are sealed and that production bores have restricted access.

Unsealed wells

Unsealed wells within the pastoral lease, such as Jowett well, can pose a water source contamination risk. Livestock and wild fauna may stray into the well, providing a direct pathway for contamination and reducing the time available for contaminants to naturally degrade before potentially entering the aquifer. Livestock and feral animals accessing the wells and decomposing animal carcasses pose a potentially significant risk of introducing pathogens into the water source.

3.1.2 Mining tenements

Mining and exploration tenements cover most of the water reserve. No mining activity currently occurs in the wellfield recharge area. Past mining activities in the water reserve (outside of the wellfield recharge area) have not impacted on the water source. If mining activities were to be undertaken within the wellfield recharge area they could result in changes to water quality and quantity. The water source could become saline or acidic and the available yield could decrease.

Proposed exploratory drilling and mining activity within the water reserve requires a program of works for drilling and a mining proposal for mining, to be referred to this department for the water source to be considered in licensing conditions. The Department of Mines and Petroleum has a memorandum of understanding in place for managing mining activities that may affect the state's water resources.

Exploration drilling poses a risk to aquifers – they can be cross-contaminated through poor drilling techniques. Uncapped drill holes can also provide a pathway for surface contaminants to reach an aquifer.

Low levels of prospecting and fossicking are reported to occur, with some evidence of past small-scale activity. Consent from the pastoralist and mining tenement holders is required by prospectors. The current low activity levels pose a minimal risk to the water source.

There are a number of abandoned mine shafts in the Menzies Water Reserve. These shafts provide a potential pathway for contamination to the aquifer through the accidental or deliberate action of people (such as illegal dumping) and through fauna access (including livestock). Decomposing animal carcasses pose a potentially significant risk of introducing pathogens into the water source.

3.1.3 Roads and tracks

The Goldfields Highway is the main transport route through the Menzies Water Reserve. It runs in a north-westerly direction and bisects the water reserve's south-western corner.

A number of unsealed tracks exist within the water reserve, and because they provide access to the bores, pose a risk to the reserve. Access to the bores increases the risk of vandalism or fuel theft: when bores are tampered with or vandalised they may become contaminated with pathogens or other contaminants. This risk can be reduced by ensuring that all the unused bores are sealed and that access to the production bores is restricted.

Another risk associated with roads is contamination from hydrocarbon and chemical spills. One option to reduce this risk includes closing tracks that are not required for the management of the water reserve or other approved land uses.

3.1.4 Unauthorised recreation

Occasionally illegal recreation occurs in the water reserve. Activities include camping, hunting and off-road vehicle use. The main water quality risks related to illegal recreation include spills of hydrocarbons and other chemicals from vehicles and pathogen contamination from human access. This activity is difficult to control within the water reserve because of the high number of access tracks and the Water Corporation's limited ability to monitor the reserve. The current low activity levels pose a minimal risk to the water source.

3.1.5 Bore maintenance

The Water Corporation maintains a number of bores within the water reserve. Its bores are powered by diesel generators with diesel storage on site. This poses a hydrocarbon contamination risk to the water source from fuel tanker spills and accidents, as well as spills and leaks from diesel storage and transfer. The fuel tanks are internally bunded, which reduces the risk of contamination from leaks.

3.1.6 Aboriginal sites of significance

Aboriginal sites of significance are those areas that Aboriginal people value as important and significant to their cultural heritage. The sites are significant because they link Aboriginal culture and tradition to place, land and people over time. These areas form an integral part of Aboriginal identity and the heritage of Western Australia. The *Aboriginal Heritage Act 1972* (WA) protects all Aboriginal sites in the state.

There are five Aboriginal sites of significance that are either partly or completely within the proposed Menzies Water Reserve. The five sites of significance are the Seven Sisters (ID 1697), Menzies field site 2 (ID 17166), Menzies field site 3

(ID 17167), Menzie ritual ground (ID 17022) and Menzies stone arrangement (ID 003).

The Menzies stone arrangement site (ID 3003) and a sixth site of significance Menzies (ID 3054) are both currently mapped but are noted to have unreliable coordinates. A field investigation to confirm the location of these sites should be considered by the relevant agencies before any developments near the assumed sites occur.

3.2 Proposed land uses and activities

The land uses and activities identified in this plan are not expected to change in the short term. Future land uses should be guided by this protection plan and recognise that the Menzies Water Reserve is protected under the *Country Areas Water Supply Act 1947* (WA). This Act may restrict or prevent some land uses from occurring in the water reserve to help protect water quality and public health. The Water Corporation, the Shire of Menzies and the Department of Water need to coordinate land-use assessment and approvals in the water reserve. Future land uses within the water reserve are expected to be in accordance with the Department of Water's WQPN no. 25: *Land use compatibility in public drinking water source areas*. Further information on development application referrals, the PDWSA water source protection framework, special control areas and relevant by-laws can be found in the Department of Water's WQPN no. 76: *Land use planning in public drinking water source areas*.

The Menzies town planning scheme is being updated. The scheme should identify and acknowledge the proposed Menzies Water Reserve as a special control area.

Table 1 Land use and potential water quality risks (groundwater)

Land use/activity	Hazard	Management priority	Compatibility of land use/activity	Best management practice guidance
Groundwater, land use and potential water quality risks				
Roads and tracks	Hydrocarbon spills and leaks from vehicles	Low	Existing sealed roads are acceptable in Priority 1 (P1) and Priority 2 (P2) areas. Unsealed roads should be managed to control access.	Water quality protection note (WQPN) no. 44: *Roads near sensitive water resources*
Bore maintenance	Hydrocarbon spills and leaks from diesel storage and transfer	Low	Water infrastructure maintenance is acceptable with conditions in P1 and P2 areas.	WQPN no. 60: *Tanks for mobile fuel storage in public drinking water source areas*
Illegal recreation – camping – hunting – off-road driving	Pathogens from human activity	Medium	Incompatible in P1 and P2 areas.	
	Hydrocarbon spills and leaks from vehicles	Medium		
Mining activities				
Fossicking/ prospecting	Hydrocarbon and other chemical spills from machinery and vehicles	Low	Mining is compatible with conditions in P1 and P2 areas.	
	Pathogens from human activity	Medium		
Abandoned mine pits and/or wells	Pathogens from animal carcasses and faeces	High	Mining is compatible with conditions in P1 and P2 areas.	
Mineral exploration and mining	Pathogens from human activity	Medium	Mining is compatible with conditions in P1 and P2 areas.	Water quality protection guideline series:

Land use/activity	Hazard	Management priority	Compatibility of land use/activity	Best management practice guidance
Mineral exploration and mining (continued)	Hydrocarbon and other chemical spills from machinery and vehicles	Low		*Mining and mineral processing*
	Dewatering-induced changes to water quality and quantity	Low		
Pastoral lease				
Stock grazing	Pathogens from animals	Medium	Pastoral leases are acceptable in P2 areas.	WQPN no. 35: *Pastoral activities within rangelands* and WQPN no. 80: *Stockyards*
	Nutrients from animal excrement	Low		
Infrastructure and maintenance	Pathogens from human activity	Medium	Pastoral leases and their related activities are acceptable in P2 areas.	WQPN no. 96: *Pest animal management in public drinking water source areas* and WQPN no. 65: *Toxic and hazardous substances – storage and use*
	Hydrocarbon and other chemical spills from machinery and vehicles	Low		
Unsealed wells	Pathogens from animal carcasses and faeces	High	Pastoral leases and their related activities are acceptable in P2 areas.	WQPN no. 35: *Pastoral activities within rangelands*

Table 2 Land use and potential water quality risks (surface water)

Land use/activity	Hazard	Management priority	Compatibility of land use/activity	Best management practice guidance
Roads and tracks	Hydrocarbons from fuel and oil leaks from vehicles	Low	Existing sealed roads are acceptable. Unsealed roads need to be managed to control access.	WQPN no.44: *Roads near sensitive water resources*
Rifle range (abandoned)	Heavy metal (lead) contamination from spent shots	Low	Active rifle ranges are incompatible in Priority 1 (P1) areas, however this rifle range is abandoned.	
Wildfire	Turbidity from erosion and ash	Low	Not applicable.	
Swimming/ recreation within dam	Pathogens from human access and possible dumping of dead animals	High	Not applicable.	
Illegal recreation – camping – hunting – off-road driving	Pathogens from human activity	Medium	Not applicable.	
	Hydrocarbons spills and leaks from vehicles	Low		
Fauna	Pathogens from animal carcasses and faeces	Low	Not applicable.	WQPN no. 96: *Pest animal management in public drinking water source areas*
	Nutrients from animal excrement	Low		

This table refers to water quality risks for Menzies Town Dam No.1. These risks have not been discussed in Section 3.1 because the dam is not used as a drinking water source supply. If the dam is used in the future, this plan will need to be updated with an appropriate risk assessment and recommendations.

4 Catchment protection strategy

4.1 Protection objectives

The objective of this plan is to ensure that safe, reliable, good quality drinking water is available to consumers now and in the future. This plan aims to achieve this objective while recognising the rights of existing approved land uses to continue and operate within the water reserve.

The protection objectives for the Menzies Water Reserve are, where possible, to improve the quality of raw water abstracted from the production bores, identify land uses that pose a contamination risk and manage those land uses to reduce the risk to water quality.

4.2 Proclaimed area

The Menzies Water Reserve was proclaimed in 1986 under the *Country Areas Water Supply Act 1947* (WA) for the purpose of protecting the public drinking water source from potential contamination.

The Department of Water recently revised the boundary of the gazetted Menzies Water Reserve to remove the area of the town site that was within the water reserve. Removing this area from the water reserve will not negatively affect the water source protection provided to the wellfield or the Town Dam No.1. For the current gazetted water reserve boundary and proposed boundary changes, please refer to Figure A2.

4.3 Priority areas

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

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

The determination of priority areas is based on the strategic importance of the land or water source, the local planning-scheme zoning, the form of land tenure and existing approved land uses or activities. For further detail, please refer to the Department of Water's Water quality protection note no.25 (WQPN no. 25): *Land use compatibility in public drinking water source areas*.

The proposed priority areas for the Menzies Water Reserve have been determined in accordance with current Department of Water policy. These areas are described below and displayed in Figure A5. The department's WQPN no. 25: *Land use compatibility in public drinking water source areas* outlines activities that are 'acceptable', 'compatible with conditions' or 'incompatible' within the different priority areas. For an explanation of the background and support for protection of PDWSAs, please refer to WQPN no. 36: *Protecting public drinking water source areas*.

The area covered by the pastoral lease within the water reserve has been classified as a P2 area and the remaining areas of allocated and unallocated Crown land have been classified as P1 areas.

It is proposed to assign the areas of Crown reserve as P1 for the following reasons:

- water from this source is the sole supply source for the Menzies town water supply scheme so it should be afforded the highest feasible level of protection
- this area has historically been managed by the Water Corporation as a P1 area, as stated in the *Menzies Water Reserve drinking water source protection assessment* (Water Corporation 2004)
- Crown land is generally managed for P1 source protection and existing land uses on the Crown land are considered compatible with P1 source protection objectives.

It is proposed to assign the area of pastoral lease as a P2 area for the following reasons:

- this area has historically been managed by the Water Corporation as a P2 area, as stated in the *Menzies Water Reserve drinking water source protection assessment* (Water Corporation 2004)
- existing and future land uses in these areas can be managed for P2 source protection objectives by implementing best management practices.

Refer to Figure A5 for the location of the P1 and P2 areas within the Menzies Water Reserve.

4.4 Protection zones

In addition to the priority areas, protection zones are defined to protect drinking water sources from contamination in the immediate vicinity of water extraction facilities. Specific conditions may apply within these zones such as restrictions on the storage of chemicals.

For further details on wellhead and reservoir protection zones, refer to the Department of Water's WQPN no. 25: *Land use compatibility in public drinking water source areas.* The department encourages land uses such as fuel and chemical storage to be sited outside the wellhead and reservoir protection zones.

4.4.1 Wellhead protection zones (WHPZ)

Wellhead protection zones (WHPZs) are generally circular (unless information is available to determine a different shape or size), with a 500 m radius around each production bore in a P1 area and a 300 m radius around each production bore in P2 and P3 areas. WHPZs do not extend outside the boundary of the water reserve.

The Menzies production bores are in the P2 area, therefore they have been allocated 300 m wellhead protection zones. Refer to Figure A5 for the location of the WHPZs within the water reserve.

Assigning a WHPZ means that best management practice should be employed for pastoral activities occurring within the WHPZ. Further information on best management practice can be found in Section 4.6: Best management practices.

4.4.2 Reservoir protection zones (RPZ)

A reservoir protection zone has not been established for the Menzies Town Dam No. 1 because it is no longer used as a drinking water supply source.

4.5 Land-use planning

It is recognised under the Western Australian Planning Commission's (WAPC) *State planning strategy* (1997) that appropriate protection mechanisms in statutory land-use planning processes are necessary to secure the long-term protection of drinking water sources. As outlined in the WAPC's Statement of planning policy no. 2.7: *Public drinking water source policy* (2003) it is appropriate that the Menzies Water Reserve, its priority areas and protection zones be recognised in the *Menzies town planning scheme*. Any development proposals within the Menzies Water Reserve that are inconsistent with advice in the Department of Water's WQPN no. 25: *Land use compatibility in public drinking water source areas* or recommendations in this plan, should be referred to the Department of Water for advice.

For further information on the integration of land-use planning and water source protection, please refer to the Department of Water's WQPN no. 36: *Protecting public drinking water source areas*.

The department's protection strategy for PDWSAs provides for lawfully established and operated developments to continue despite those facilities posing a potential level of risk to water quality that would not be accepted for new developments. The department will provide advice to landowners/operators on measures to improve these facilities and reduce water quality contamination risks.

4.6 Best management practices

There are opportunities to significantly reduce water contamination risks by carefully considering design and management practices. To help protect water sources, the Department of Water will continue to encourage the adoption of best management practices for various land uses.

Guidelines on best management practices for many land uses are available in the form of industry codes of practice, environmental guidelines and water quality protection notes. They outline the recommended practices to ensure the protection of water quality and can thus help managers reduce any detrimental effects of their operations. Such guidelines have been developed in consultation with stakeholders such as industry groups, agricultural producers, state government agencies and technical advisers. Examples include WQPN no. 35: *Pastoral activities within rangelands* and WQPN no. 44: *Roads near sensitive water resources* which are listed in this plan's References section.

Education and creating awareness (e.g. signage and information) are also key mechanisms for protecting water quality, especially for people visiting the area. A brochure will be produced once this plan is finalised, describing the Menzies Water Reserve, its location and the main threats to water quality. 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 water in public drinking water source areas within country areas of the state is protected under the *Country Areas Water Supply Act 1947* (WA). Proclamation of PDWSAs 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 PDWSAs, to be an important mechanism to protect water quality.

It is recommended that signs be erected on the boundaries of this water reserve to educate and advise the public about activities that are prohibited or regulated. This plan recommends that the existing delegation of surveillance and by-law enforcement to the Water Corporation be continued.

4.8 Emergency response

The escape of contaminants during unforeseen incidents and the use of chemicals during emergency responses can result in water contamination. The Menzies local emergency management committee (LEMC), through the Goldfields-Esperance emergency management district, should be familiar with the location and purpose of the Menzies Water Reserve. 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 the HAZMAT team for incidents in the Menzies Water Reserve.

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

4.9 Implementation of this plan

Table 1 identifies the potential water quality risks associated with existing land uses in the proposed Menzies Water Reserve. Further information and the recommended protection strategies to deal with those risks are outlined in Appendix C.

When the final *Menzies Water Reserve drinking water source protection plan* is complete, an implementation strategy will be drawn up based on the recommendations in Appendix C.

5 Recommendations

The following recommendations apply to the entire Menzies Water Reserve. The bracketed stakeholders are those expected to have an interest in the relevant recommendation being implemented.

1 The boundary of the Menzies Water Reserve should be amended under the *Country Areas Water Supply Act 1947* (WA). (Department of Water)

2 Develop an implementation strategy for this plan's recommendations (including the recommended protection strategies as detailed in Appendix C) showing responsible stakeholders and planned timeframes. (Department of Water, applicable stakeholders)

3 The Menzies town planning scheme should incorporate this plan and reflect the identified Menzies Water Reserve boundary, P1 and P2 areas and protection zones in accordance with the WAPC's Statement of planning policy no. 2.7: *Public drinking water source policy*. (Shire of Menzies)

4 All development proposals within the Menzies Water Reserve that are inconsistent with the Department of Water's WQPN no. 25: *Land use compatibility in public drinking water source areas* or recommendations in this plan should be referred to the Department of Water for advice and recommendations. (Department of Planning, Shire of Menzies, proponents of proposals)

5 Incidents covered by WESTPLAN–HAZMAT in the Menzies Water Reserve should be addressed by ensuring that:

- the Shire of Menzies LEMC is aware of the location and purpose of the Menzies Water Reserve
- the locality plan for the Menzies Water Reserve is provided to the FESA headquarters for the HAZMAT emergency advisory team
- the Water Corporation acts in an advisory role during incidents in the Menzies Water Reserve
- personnel dealing with WESTPLAN–HAZMAT incidents in the area have ready access to a locality map of the Menzies Water Reserve and information to help them recognise the potential impacts of spills on drinking water quality. (Water Corporation)

6 The existing monitoring program should be maintained and enhanced to identify any incompatible land uses or potential threats within the Menzies Water Reserve. (Water Corporation)

7 Signs should be erected along the boundary of the Menzies Water Reserve to define the location and promote awareness of the need to protect drinking water quality. Signs should include an emergency contact telephone number. (Water Corporation/Department of Water)

8 A review of this plan should be undertaken after five years. (Department of Water)

Appendices

Appendix A Figures

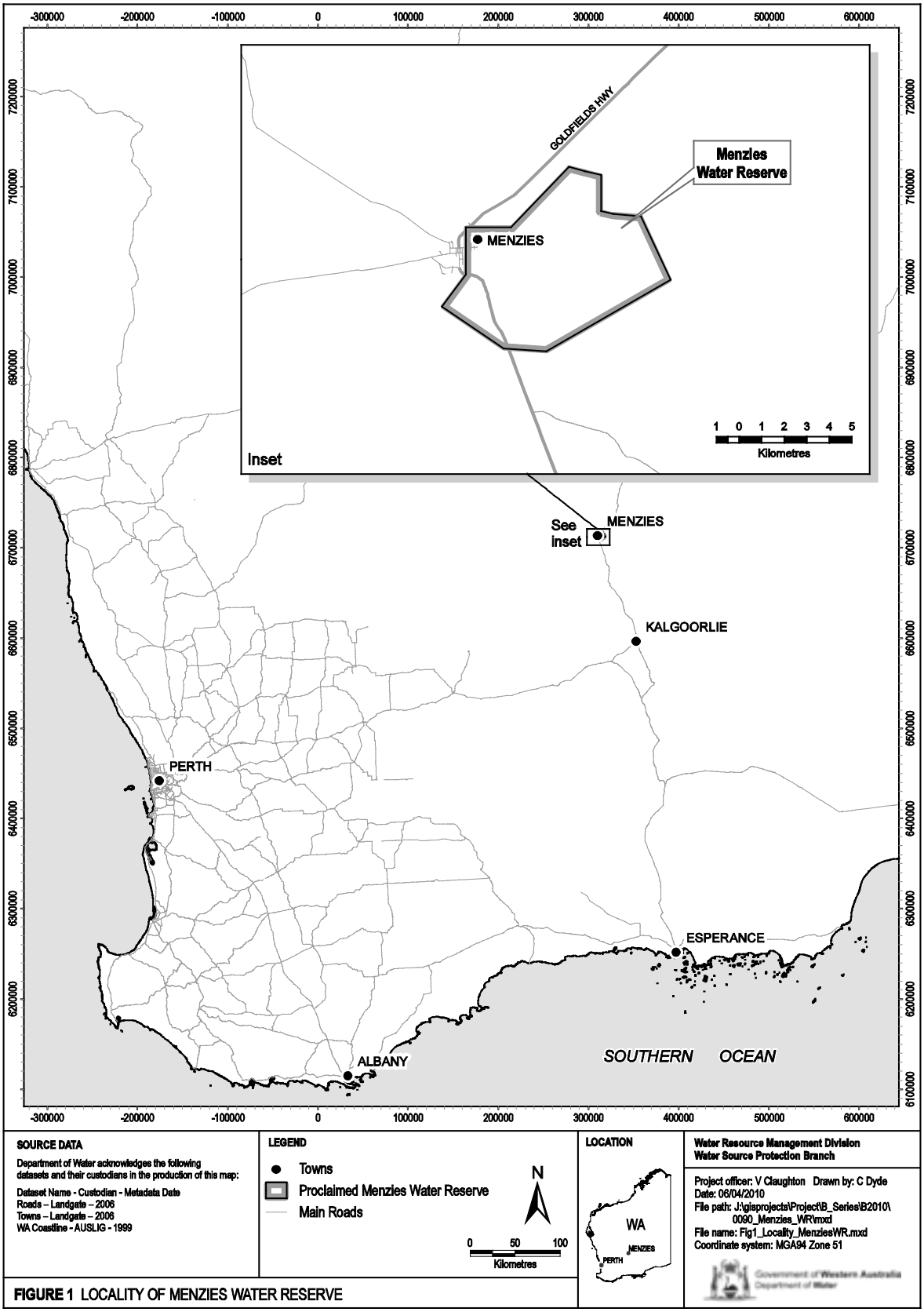

FIGURE 1 LOCALITY OF MENZIES WATER RESERVE

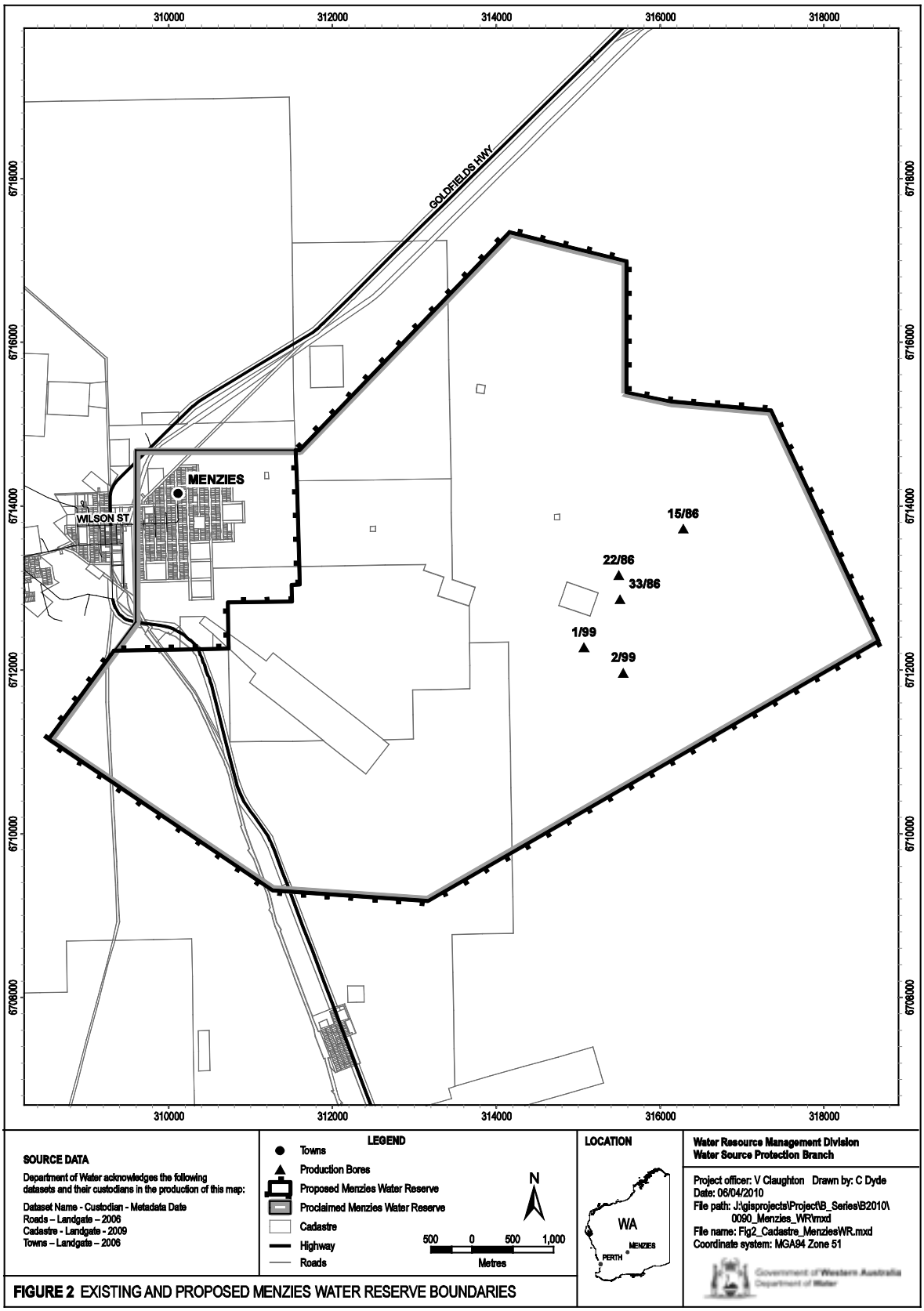

FIGURE 2 EXISTING AND PROPOSED MENZIES WATER RESERVE BOUNDARIES

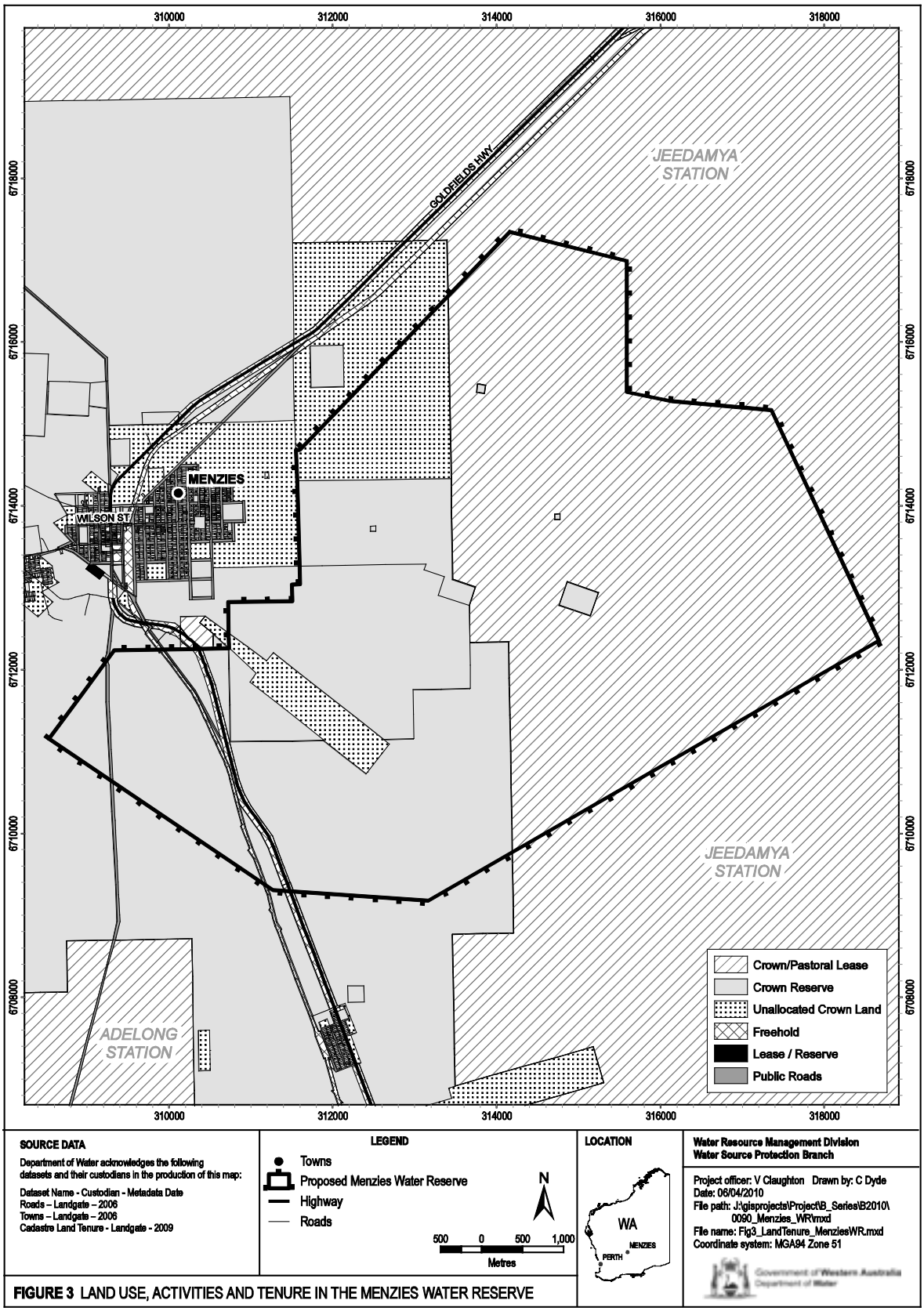

FIGURE 3 LAND USE, ACTIVITIES AND TENURE IN THE MENZIES WATER RESERVE

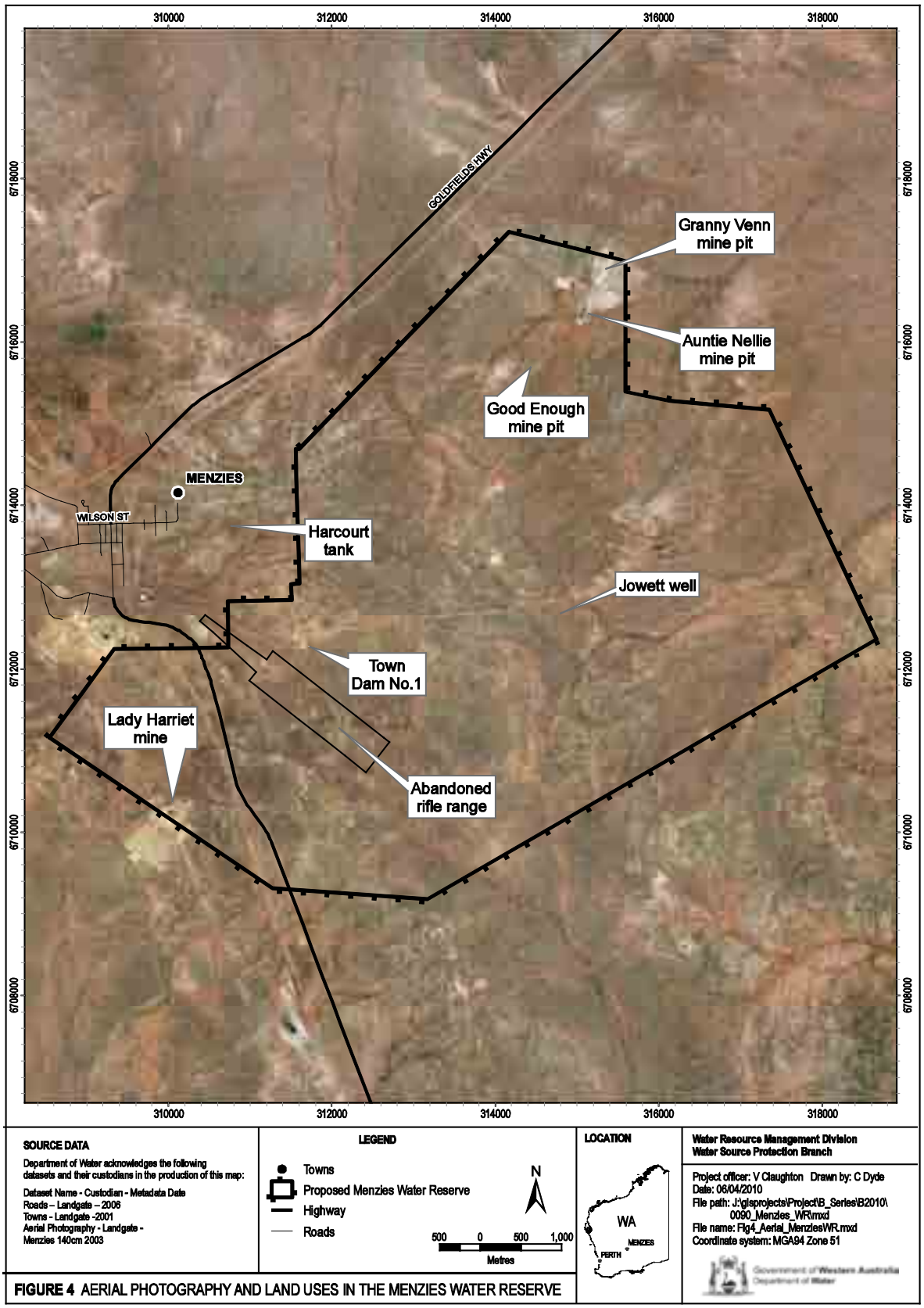

FIGURE 4 AERIAL PHOTOGRAPHY AND LAND USES IN THE MENZIES WATER RESERVE

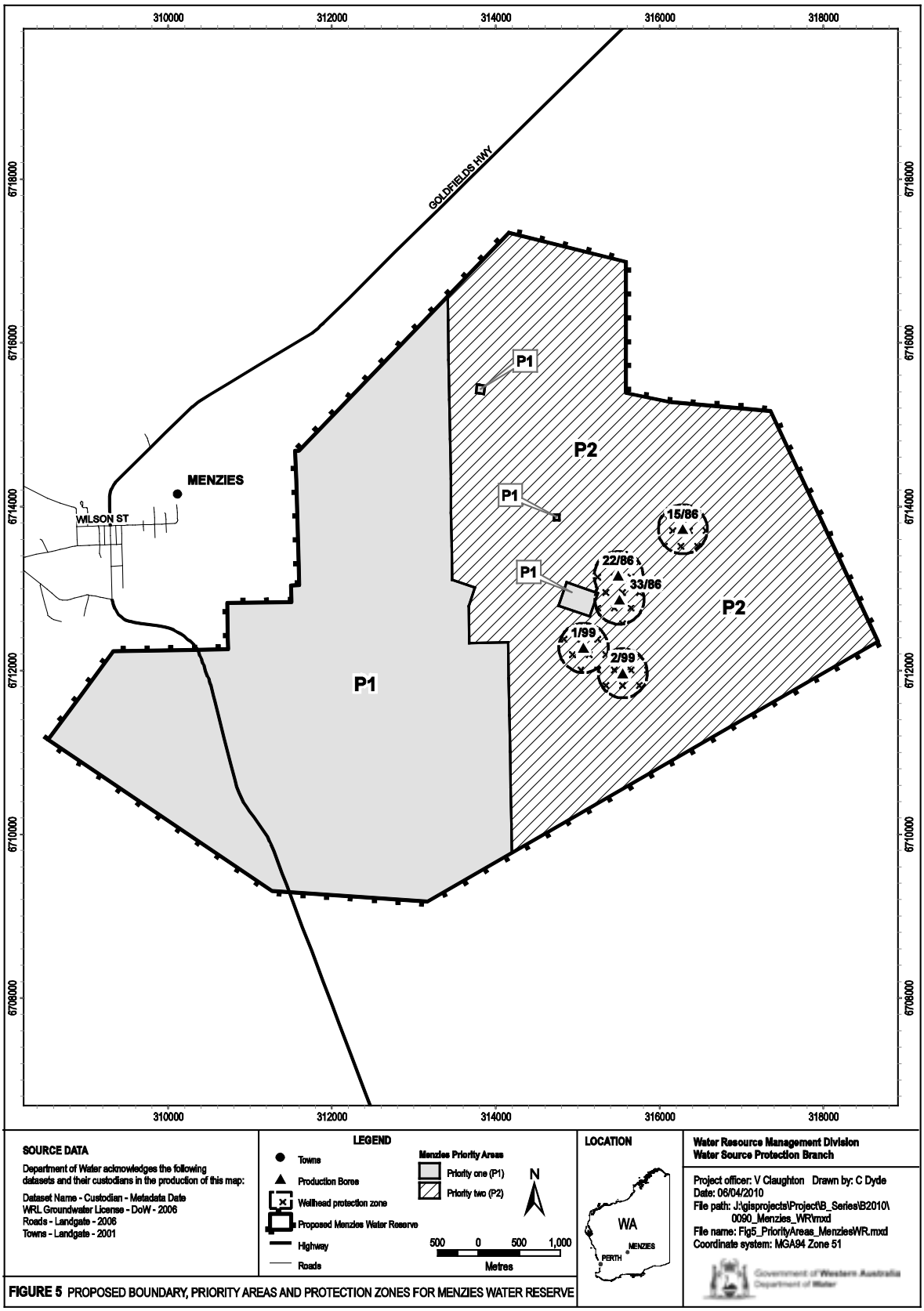

FIGURE 5 PROPOSED BOUNDARY, PRIORITY AREAS AND PROTECTION ZONES FOR MENZIES WATER RESERVE

Appendix B Water quality data

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

The Water Corporation has monitored the raw (source) water quality from Menzies Water Reserve 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:

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

Following is data representative of the quality of raw water in Menzies wellfield. 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 customer's tap. Results that exceed the ADWG have been shaded to give an indication of potential raw water quality issues associated with this source.

It is important to appreciate that the raw water data presented does not represent the quality of drinking water distributed to the public. Barriers such as storage and water treatment, to name a few, exist downstream of the raw water to ensure it meets the requirements of the ADWG. For more information on the quality of drinking water supplied to Menzies refer to the most recent Water Corporation drinking water quality annual report at <www.watercorporation.com.au/W/waterquality_annualreport.cfm>.

Comprehensive water analyses are undertaken at each of the bores, rather than at the composite raw water point, to enable the wellfield operating strategy to be adjusted as required. The water quality data presented below combines the minimum, maximum and range values from each of the bores for each parameter.

Aesthetic-related characteristics

Aesthetic water quality analyses for raw water from Menzies wellfield are summarised in Table B1.

The values are taken from ongoing monitoring for the period July 2004 to June 2009. 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 shaded.

Aesthetic-related detections for Menzies

Parameter	Units	ADWG aesthetic guideline value*	Menzies bores 15/86, 22/86, 33/86, 1/99, 2/99	
			Range	Median
Chloride	mg/L	250	120-270	165
Colour – true	TCU	15	<1–3	<1
Hardness as $CaCO_3$	mg/L	200	158–401	289.5
Iron unfiltered	mg/L	0.3	<0.003–6.5	0.004
Manganese unfiltered	mg/L	0.1	0.004–0.035	0.014
pH	NTU	6.5–8.5	5.98–7.7	6.96
Sodium	mg/L	180	73–215	115
Total filterable solids by summation	mg/L	500	540–1090	844
Turbidity	NTU	5	1.4–16	6.4
Zinc	mg/L	3	<0.02–0.06	0.04

* 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 Menzies 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 July 2004 and June 2009 are summarised in Table B2. Any parameters that have on occasion exceeded the ADWG are shaded.

Health-related detections for Menzies

Parameter	Units	ADWG health guideline value*	Menzies bores 15/86, 22/86, 33/86, 1/99, 2/99	
			Range	Median
Arsenic^	mg/L	0.007	<0.002–0.5	0.015
Barium	mg/L	0.7	0.0008–0.045	0.01
Boron	mg/L	4.0	0.3–0.7	0.3
Cadmium	mg/L	0.002	<0.0002–0.0002	<0.0002
Chromium	mg/L	0.05	<0.0005–0.009	0.001
Copper	mg/L	2.0	0.004–0.08	0.01
Fluoride	mg/L	1.5	0.35–1.2	0.65
Iodide†	mg/L	0.1	0.1	0.1
Lead	mg/L	0.01	<0.002–0.005	0.003
Manganese unfiltered	mg/L	0.5	<0.002–10.0	<0.002
Molybdenum	mg/L	0.05	0.003–0.08	0.009
Nickel	mg/L	0.02	0.008–0.045	0.016
Nitrate as N	mg/L	11.29	0.31–18.0	14.0
Nitrite as N	mg/L	0.91	<0.002–0.88	<0.002
Nitrite plus Nitrate as N	mg/L	11.29	0.29–18.0	13.85
Selenium	mg/L	0.01	<0.003–0.007	<0.003
Sulphate	mg/L	500	61.0–145.0	98.8
Uranium	mg/L	0.02	<0.001–0.003	<0.001

^ Treatment is in place for arsenic reduction.

† Parameter with less than three sampling events.

* 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 (NHRMC & ARMCANZ 1996).

Microbiological contaminants

Microbiological testing of raw water samples from Menzies wellfield is currently conducted on a monthly 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 detection of *Escherichia. coli* in raw water abstracted from any bore may indicate possible contamination of faecal material through ingress in the bore or recharge through to the aquifer (depending on aquifer type).

During the review period of July 2004 to June 2009, positive *Escherichia. coli* counts were recorded in 1.6 per cent of samples collected from Menzies wellfield. The low occurrence of *Escherichia. coli* detections is indicative of minimal contamination of the groundwater from faecal sources.

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

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

Land use, potential water quality risks and recommended protection strategies (Groundwater)

Land use/ activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Pastoral lease – infrastructure and maintenance	Pathogens from human activity	Low	There is currently minimal activity on the pastoral lease, with no evidence of recent infrastructure construction or maintenance by the pastoralist.	● Water quality monitoring ● Sealed bores ● Fenced secure bore compounds ● Water Corporation surveillance	● Adherence to the department's Water quality protection note (WQPN) no. 80: *Stockyards* and WQPN no. 35*: Pastoral activities within rangelands.*
	Hydrocarbon contamination caused by fuel and oil leaks from vehicles and machinery	Low			
Stock grazing – sheep and goats	Pathogens from animal excrement and carcasses	Medium	Minimal stock grazing occurs on the pastoral lease. Low stocking rates reduce the risk associated with this land use.	● Water quality monitoring ● Sealed bores ● Fenced secure bore compounds ● Water Corporation surveillance	● Locate stock watering points down-slope of the bores ● Uncapped wells and bores should be backfilled and capped.
	Nutrients from animal excrement	Low			

Land use/ activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	**Management priority**			
Mining operation and exploratory drilling	Pathogens from human activity	Medium	No mining activity currently occurs in the wellfield recharge area. Past mining activities in the water reserve, outside of the recharge area, have not impacted on the water source. Proposed exploratory drilling and mining activity within the water reserve requires a program of works for drilling and a mining proposal for mining, to be referred to the Department of Water for comment.	● Water quality monitoring ● Sealed bores ● Fenced secure bore compounds ● Water Corporation surveillance ● Department of Environment and Conservation (DEC) and Department of Mines and Petroleum (DMP) licensing and reviews	● Ensure adherence to the Water quality protection guideline series: *Mining and mineral processing* ● Ensure compliance with DMP mining tenement conditions and endorsements.
	Hydrocarbon contamination caused by fuel and oil leaks from vehicles and machinery	Low			
	Changes in water quality	Low			
Mining – prospecting	Pathogens from human activity	Medium	Low levels of prospecting and fossicking are reported to	● Water quality monitoring	● Ensure adherence to the Water quality protection

Land use/ activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	**Management priority**			
and fossicking	Hydrocarbon contamination caused by fuel and oil leaks from vehicles and machinery	Low	occur, with some evidence of past small-scale activity. Consent from the pastoralist and mining tenement holders is required by prospectors. The current low activity levels pose a minimal risk to the water source.	● Sealed bores ● Fenced secure bore compounds ● Water Corporation surveillance	guideline series: *Mining and mineral processing* ● Ensure compliance with DMP mining tenement conditions and endorsements.
Mining – old mine pits	Pathogen contamination caused by animal wastes and carcasses.	High	Old shafts provide a potential pathway for contamination to the aquifer as they reduce the time available for contaminants to naturally degrade before potentially entering the aquifer. Livestock and feral animals accessing the shafts and decomposing animal carcasses pose a potentially significant risk of introducing pathogens into the water source.	● Water quality monitoring ● Water Corporation surveillance	● Ensure compliance with DMP mining tenement conditions and endorsements.

Land use/ activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	**Management priority**			
Illegal recreation – hunting – camping – off-road vehicles	Pathogens from human activity	Medium	Occasional recreational activity, including hunting, camping and off-road vehicle use, is reported to occur. There are a number of tracks that provide access to the water reserve. The current level of activity is low and poses little contamination risk to the water reserve.	● Water quality monitoring ● Sealed bores ● Fenced secure bore compounds ● Water Corporation surveillance	● Increase monitoring of water reserve ● Use signs to inform people of their presence in the water reserve and the need to protect water quality: signage should include an emergency contact number ● Investigate closing or installing gates on unnecessary roads that currently provide public access
	Hydrocarbon contamination from fuel spills or accidents	Medium			

Land use/ activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Bore maintenance	Hydrocarbon contamination caused by spills and leaks from diesel storage and transfer	Low	The Water Corporation bores are powered with diesel generators. These generators are internally bunded. Spills and leaks are rare with refuelling and transport conducted by experienced and trained operators.	● Internally bunded diesel storage tanks ●Water quality monitoring ● Sealed bores ● Trained and experienced Water Corporation operators ● Water Corporation remedial action in the event of a spill	● Continue current monitoring and practices ● Inspect bore compounds for signs of diesel leaks ● Amend any spills and remove contaminated material ● Adhere to Department of Water's WQPN no. 65: *Toxic and hazardous substances – storage and use* and WQPN no. 10: *Contaminant spills – emergency response*
Unsealed wells	Contamination from pathogens caused by animals wastes and carcasses	High	Several uncovered wells are located in the wellfield recharge area. These wells provide a direct route for animals to access and contaminate the groundwater with pathogens.	● Water quality monitoring ● Water Corporation management	● Seal or fence off all the uncovered wells/bores in the water reserve ● Erect signage and secure fencing around Jowett well

Land use/ activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Roads and tracks	Hydrocarbon contamination from fuel and chemical spills	Low	There are a number of unsealed roads in the water reserve.	● Water quality monitoring ● Water Corporation surveillance	● Incident management procedures in place with Main Roads (WA) and local shires ● Use signs to inform people of their presence in the water reserve and the need to protect water quality: signage should include an emergency contact number ● Planning controls in place ● Investigate installing gates to unnecessary roads that currently provide public access ● Maintain HAZMAT emergency response ● Ensure adherence to WQPN no. 44: *Roads near sensitive water resources* and WQPN no. 10: *Contaminant spills – emergency response*.

Land use, potential water quality risks and recommended protection strategies (Surface water)

This table refers to the water quality risks for Menzies Town Dam No.1. These risks have not been discussed in Section 3.1 because the dam is not currently used as a drinking water source supply. The management priorities given in this table will not be relevant unless the Menzies Town Dam No.1 is used as a drinking water source. If this dam is used as a drinking water source, this plan will need to be updated with an appropriate risk assessment and recommendations.

Land use/ activity	**Potential water quality risks**		**Consideration for management**	**Current preventative measures**	**Recommended protection strategies**
	Hazard	**Management priority**			
Roads and tracks	Hydrocarbon contamination from fuel and chemical spills	Low	There are a number of unsealed roads in the water reserve. Most inflow to the reservoir occurs following infrequent heavy rainfall events which have the potential to transport significant amounts of material into the reservoir.	● Water quality monitoring ● Water Corporation surveillance ● HAZMAT emergency response.	● Incident management procedures in place with Main Roads (WA) and local shires ● Use signs to inform people of their presence in the water reserve and the need to protect water quality: signage should include an emergency contact number ● Investigate closing unused roads or installing gates to unnecessary roads that currently provide public access ● Ensure adherence to WQPN no. 44: *Roads near sensitive water resources* and WQPN no. 10: *Contaminant spills – emergency response*.
	Turbidity	Low			

Land use/ activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	**Management priority**			
Rifle range	Heavy metal (lead) contamination from spent shots	Low	A historic abandoned rifle range is located south of Menzies, more than 2 km from Menzies Dam. The likelihood of lead contamination from a spent shot is very low.	● Activity ceased ● Water quality monitoring before using the water source	● Implement water quality monitoring before using the water supply source
Fauna – native and introduced	Pathogens from animal faeces and carcasses	Low	The reservoir is fenced, however small animals can currently gain access through the inlet channel	● Water quality monitoring before using the water source ● Fenced water body ● Water Corporation maintenance	● Implement a pest management program ● Increase monitoring of the dam for dead or introduced fauna
	Nutrients from animal excrement	Low			
Recreation	Pathogens from human activity	Medium	There a number of tracks allowing access to the	● Water quality monitoring	● Increase monitoring of the water body and surrounding water reserve

Land use/ activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	**Management priority**			
– hunting, – camping – off-road vehicles	Hydrocarbon contamination caused by fuel and oil leaks from vehicles and machinery	Low	water reserve. Vehicles are routinely dumped in the catchment then periodically removed by a community group. The current low level of recreational activity poses a minimal water contamination risk.	● Fenced water body ● Water Corporation surveillance and signage ● Water quality monitoring before using the water source.	● Use signs to inform people of their presence in the water reserve and the need to protect water quality: signage should include an emergency contact number ● Investigate closing or installing gates on unused roads that currently provide public access
Swimming/ human access to the dam	Pathogens from human contact	High	It is not known if swimming occurs in the dam, however evidence of trespassing has been observed.	● Fenced water body ● Water Corporation surveillance and signage ● Water quality monitoring before using the water source.	● Increased monitoring of the water body and surrounding water reserve ● Increase signage

Land use/ activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	**Management priority**			
Wildfire	Nutrients from decomposition materials	Low	Wildfires in the area are rare, however they could be associated with thunder storms, which increases the potential for rapid transport of decomposed and eroded material into the reservoir. The presence of people in the catchment increases the likelihood of wildfire.	● Water Corporation surveillance ● Water Corporation post event management ● Water quality monitoring before using the water source.	● Continue current fire management regime ● WC monitors water quality post wildfire before using the water source ● Streamline and reservoir buffers are considered before applying chemical fire extinguishers ● Liaise closely with the shire's local emergency management committee through the Goldfields-Esperance emergency management district. The committee should be familiar with the location and purpose of the Menzies PDWSA. Provide a locality plan to the fire and rescue services headquarters for the hazardous materials (HAZMAT) emergency advisory team.
	Turbidity caused by erosion	Low			

Appendix D Photographs

Figure D1 Bore 22/99 surrounded by fencing

Figure D2 Self-bunded diesel wrap tank

Figure D3 Menzies Town Dam No. 1

Figure D4 Abandoned mine pit filled with water within the water reserve

Figure D5 Abandoned mine shaft within the water reserve

Figure D6 Jowett well

List of shortened forms

ADWG	*Australian drinking water guidelines*
AHD	Australian height datum
ANZECC	Australian and New Zealand Environment Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
CA	catchment area
EC	electrical conductivity
HAZMAT	hazardous materials
kL	kilolitre
km	kilometre
LEMC	local emergency management committee
m	metres
mg/L	milligram per litre
mL	millilitre
ML	megalitre
mm	millimetre
NHMRC	National Health and Medical Research Council
NRMMC	Natural Resource Management Ministerial Council
NTU	nephelometric turbidity units
PSC 88	public sector circular number 88
PDWSA	public drinking water source area
RPZ	reservoir protection zone
TCU	true colour units
TDS	total dissolved solids
WHPZ	wellhead protection zone
WESTPLAN–HAZMAT	Western Australian plan for hazardous materials

Glossary

Abstraction The pumping of groundwater from an aquifer, or the removal of water from a waterway or water body.

Adsorb Adsorb means to accumulate on the surface of something. For example, microorganisms can absorb onto soil particles.

Aesthetic guideline value The concentration or measure of a water quality characteristic that is associated with acceptability of water to the consumer, e.g. appearance, taste and odour (NHMRC & NRMMC 2004a).

Allocation The quantity of water that a licensee is permitted to abstract is their allocation, usually specified in kilolitres per annum (kL/a).

Aquifer An aquifer is a geological formation or group of formations able to receive, store and transmit significant quantities of water.

Australian drinking water guidelines The *National water quality management strategy: Australian drinking water guidelines 6, 2004* (NHMRC & NRMMC 2004a) (ADWG) outlines acceptable criteria for the quality of drinking water in Australia (see this plan's Bibliography).

Australian height datum Australian height datum is the height of land in metres above mean sea level. For example, the AHD is +0.026 m at Fremantle.

Bore A bore is a narrow, lined hole drilled into the ground to monitor or draw groundwater (also called a well).

Bore field A group of bores to monitor or withdraw groundwater is referred to as a bore field (also see *wellfield*).

Catchment The physical area of land which intercepts rainfall and contributes the collected water to surface water (streams, rivers, wetlands) or groundwater.

Colony forming units Colony forming units are a measure of pathogen contamination in water.

Confined aquifer An aquifer that is confined between non-porous rock formations (such as shale and siltstone) and therefore contains water under pressure.

Department of Environment and Conservation The Department of Environment and Conservation was established on 1 July 2006, bringing together the Department of Environment and the Department of Conservation and Land Management.

Diffuse source	A diffuse source of pollution originates from a widespread non-specific area (e.g. urban stormwater runoff, agricultural infiltration) as opposed to a particular point source (see *point source pollution*).
Electrical conductivity	This estimates the volume of TDS or the total volume of dissolved ions in a solution (water) corrected to 25ºC. Measurement units include millisiemens per metre and microsiemens per centimetre.
Fractured rock	An aquifer where groundwater is present in the fractures, joints, solution cavities, bedding planes and zones of weathering igneous, metamorphic and deformed sedimentary rocks. Fractured rock aquifers are highly susceptible to contamination from land-use activities when aquifers crop-out or sub-crop close to the land surface.
Gigalitre	A gigalitre is equivalent to 1 000 000 000 litres or one million kilolitres.
Health guideline value	The concentration or measure of a water quality characteristic that, based on current knowledge, does not result in any significant risk to the health of the consumer over a lifetime of consumption (NHMRC & NRMMC 2004a).
Hydrocarbons	A class of compounds containing only hydrogen and carbon, such as methane, ethylene, acetylene and benzene. Fossil fuels such as oil, petroleum and natural gas all contain hydrocarbons.
Hydrogeology	The study of groundwater, especially relating to the distribution of aquifers, groundwater flow and groundwater quality.
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.
mg/L	A milligram per litre (0.001 grams per litre) is a measurement of a total dissolved solid in a solution.
Millisievert	A millisievert is a measure of annual radiological dose, with a natural dose equivalent to 2 mSv/yr.
Millisiemens per metre	Millisiemens per metre is a measure of electrical conductivity of a solution or soil and water mix that provides a measurement of salinity.
Most probable number	Most probable number is a measure of microbiological contamination.

Nephelometric turbidity units	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, particularly inorganic compounds of nitrogen (nitrate and ammonia) and phosphorous (phosphate) dissolved in water which provide nutrition (food) for plant growth.
Pathogen	A disease-producing organism that can cause sickness and sometimes death through the consumption of water, including bacteria (such as *Escherichia coli*), protozoa (such as *Cryptosporidium* and *Giardia*) and viruses.
Pesticides	Collective name for a variety of insecticides, fungicides, herbicides, algicides, fumigants and rodenticides used to kill organisms.
pH	A logarithmic scale for expressing the acidity or alkalinity of a solution. A pH below seven indicates an acidic solution and above seven indicates an alkaline solution.
Point source pollution	Pollution originating from a specific localised source, e.g. sewage or effluent discharge; industrial waste discharge.
Pollution	Water pollution occurs when waste products or other substances (effluent, litter, refuse, sewage or contaminated runoff) change the physical, chemical or biological properties of the water, adversely affecting water quality, living species and beneficial uses.
Public drinking water source area	Includes all underground water pollution control areas, catchment areas and water reserves constituted under the *Metropolitan Water Supply Sewerage and Drainage Act 1909* (WA) and the *Country Areas Water Supply Act 1947* (WA).
Public sector circular number 88	A state government circular produced by the Department of Health providing guidance on appropriate herbicide use within water catchment areas.
Recharge	Recharge is the action of water infiltrating through the soil/ground to replenish an aquifer.
Recharge area	An area through which water from a groundwater catchment percolates to replenish (recharge) an aquifer. An unconfined aquifer is recharged by rainfall throughout its distribution. Confined aquifers are recharged in specific areas where water leaks from overlying aquifers, or where the aquifer rises to meet the surface.

Reservoir	A reservoir, dam, tank, pond or lake that forms part of any public water-supply works.
Reservoir protection zone	A buffer measured from the high water mark of a drinking water reservoir, and inclusive of the reservoir (usually 2 km). This is referred to as a prohibited zone under the Metropolitan Water Supply Sewerage and Drainage Act By-laws 1981 (WA).
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 and industrial use or for irrigation.
Stormwater	Rainwater that has run off the ground surface, roads, paved areas etc., and is usually carried away by drains.
Total dissolved solids	Total dissolved solids consist of inorganic salts and small amounts of organic matter that are dissolved in water. Clay particles, colloidal iron and manganese oxides, and silica fine enough to pass through a 0.45 micrometer filter membrane can also contribute to total dissolved solids. Total dissolved solids comprise sodium, potassium, calcium, magnesium, chloride, sulfate, bicarbonate, carbonate, silica, organic matter, fluoride, iron, manganese, nitrate (and nitrite) and phosphate (NHMRC & NRMMC 2004a).
Total filterable solids by summation	Total filterable solids by summation is a water quality test which is a total of the following ions: Na (sodium), K (potassium), Ca (calcium), Mg (magnesium), Cl equivalent (chloride), alkalinity equivalent, SO_4 equivalent (sulfate) or S (sulfur) in grams, Fe (iron), Mn (manganese), and SiO_2 (silicon oxide). It is used as a more accurate measure than total dissolved solids (TDS). The higher the value, the more solids that are present and generally the saltier the taste.
Treatment	Application of techniques such as settlement, filtration and chlorination to render water suitable for specific purposes, including drinking and discharge to the environment.
True colour units	True colour units are a measure of degree of colour in water.
Turbidity	The cloudiness or haziness of water caused by the presence of fine suspended matter.

Unconfined aquifer	An aquifer in which the upper surface of water is lower than the top of the aquifer itself. The upper surface of the groundwater within the aquifer is called the watertable.
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	Water quality is the collective term for the physical, aesthetic, chemical and biological properties of water.
Water reserve	A water reserve is an area proclaimed under the *Country Areas Water Supply Act 1947* (WA) or the *Metropolitan Water Supply Sewerage and Drainage Act 1909* (WA) for the purposes of protecting a drinking water supply.
Watertable	The upper saturated level of the unconfined groundwater is referred to as the watertable.
Wellfield	A wellfield is a group of bores located in the same area used to monitor or withdraw groundwater.
Wellhead	The top of a well (or bore) used to draw groundwater is referred to as a wellhead.
Wellhead protection zone	A wellhead protection zone (WHPZ) is usually declared around wellheads in public drinking water source areas to protect the groundwater from immediate contamination threats in the nearby area.

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– WQPN no. 44: *Roads near sensitive water resources*
– WQPN no. 60: *Tanks for mobile fuel storage in public drinking water source areas*
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