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

Watheroo Water Reserve

Drinking water source protection review

Watheroo town water supply

Securing Western Australia's water future

Water resource protection series
Report WRP 150
November 2016

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Summary

This drinking water source protection review considers changes that have occurred in and around the Watheroo Water Reserve since completion of the *Watheroo Water Reserve water source protection plan* (Water and Rivers Commission 1999). This review should be read in conjunction with the 1999 plan. Both of these documents are available on our website or by contacting us.

Watheroo is a small town located 40 km north of Moora and about 225 km north of Perth, in the Shire of Moora. The Watheroo area has a population of 189 residents (ABS 2011).

The Water Corporation supplies water to the town of Watheroo from three production bores – 10/90, 11/90 and 3/63 – located on privately owned land. These bores are located in secure compounds managed by the Water Corporation and draw water from a shallow, unconfined aquifer which makes them vulnerable to contamination. The establishment of wellhead protection zones around these bores, the assignment of a priority 1 area on a small parcel of Crown land and the continuation of the priority 2 area across the rest of the Watheroo Water Reserve will help reduce the contamination risks.

This document has been prepared in consultation with key stakeholders, including the Water Corporation, landowners within wellhead protection zones and the Shire of Moora.

The main changes since the 1999 plan are:

- the decommissioning of production bores 5/78 and 7/78
- the introduction of production bores 10/90 and 11/90.

This review is consistent with the *Australian drinking water guidelines* (ADWG) (NHMRC & NRMMC 2011) and State planning policy no. 2.7: *Public drinking water source policy.*

The following table shows important information about the Watheroo Water Reserve.

Key information about the Watheroo Water Reserve	
Status of this report	This report has been prepared based on information for the 2014/15 financial year
Local government authority	Shire of Moora
Location supplied	Watheroo
Water service provider	Water Corporation
Aquifer type	Unconfined (shallow, vulnerable to contamination)

Key information about the Watheroo Water Reserve	
Licensed abstraction	55 000 kL/year
Number of bores	3
Bore names and GPS coordinates	3/63 (E 405 462, N 6 649 262, zone 50) 10/90 (E 405 271, N 6 649 654, zone 50) 11/90 (E 405 349, N 6 649 501, zone 50) Decommissioned 5/78 (E 405 454, N 6 649 249, zone 50) Decommissioned 7/78 (E 405 459, N 6 649 254, zone 50)
Dates of drinking water source protection reports	1999 – *Watheroo Water Reserve water source protection plan* 2015 – *Watheroo Water Reserve drinking water source protection review* (this document)
Consultation	1999 – extensively consulted. The draft plan was released for comment to key stakeholders including Water Corporation, Ministry for Planning, Department of Environmental Protection, Department of Land Administration, Department of Conservation and Land Management, Shire of Moora, Conservation Council and affected landowners. 2013 and 2014 – mail-out to landowners within new proposed wellhead protection zones, and consultation with key stakeholders including the Water Corporation, South West Aboriginal Land and Sea Council and the Shire of Moora.
Proclamation status	Proclaimed on 4 December 2002 under the *Country Areas Water Supply Act 1947*.

1 Review of Watheroo's drinking water source protection plan

Boundary, priority areas and protection zones

The Watheroo Water Reserve was proclaimed in 2002 under the *Country Areas Water Supply Act 1947*. At that time the water reserve included one 300 m wellhead protection zone (WHPZ), for three bores (given their close proximity), and was managed as a priority 2 (P2) area to minimise water quality risks (Figure A4).

Of the three production bores that were active in 1999, two have been replaced. These two new production bores are 10/90 and 11/90, located north of the decommissioned bores 5/78 and 7/78. The original production bore 3/63 remains in use but due to its high iron levels it is predominately used as an emergency backup bore. Production bore 3/63 and the decommissioned bores 5/78 and 7/78 are located within the Watheroo Water Reserve water treatment compound as shown in Figure C3. The new bores are located in two separate secure compounds.

This change in production bores means that the previous WHPZ should be removed and three new 300 m WHPZs should be assigned around each of the current production bores.

The 1999 plan assigned the whole of the Watheroo Water Reserve as a P2 area. This review recommends that the majority of the Watheroo Water Reserve remain as P2, except one parcel of Crown reserve on the northern boundary of the water reserve which is proposed to be assigned as a priority 1 (P1) area. These priority areas are consistent with the Shire of Moora's *Local Planning Scheme no.4*, existing zoning and current land uses. Please refer to Figure A4 for the proposed priority areas and wellhead protection zones within the Watheroo Water Reserve.

The boundary of the Watheroo Water Reserve will remain unchanged.

The Watheroo Water Reserve boundary, priority areas and protection zones above have been determined in accordance with current Department of Water policy.

If you require more information about how we protect drinking water sources, please read Appendix D.

Update on water supply scheme

The Watheroo Water Reserve bore field consists of three production bores, (10/90, 11/90 and 3/63) which all draw water from the unconfined Perth superficial aquifer. Bore 3/63 is drilled to 38 m and is screened between 32 m and 38 m. Bore 10/90 is drilled to 59 m and is screened between 41.7 m and 53.7 m and production bore 11/90 is drilled to 63 m and is screened between 47.6 m and 59.6 m. Please refer to Figure A4 for the location of the current production bores in the Watheroo Water Reserve. Production bores 10/90 and 11/90 are new production bores that replaced the decommissioned production bores 5/78 and 7/78 described in the 1999 plan.

Groundwater from the bore field is transported to treatment facilities located in a secure compound with production bore 3/63. The decommissioned bores are also located in this compound but do not pose a contamination risk to the aquifer because they have been appropriately sealed.

The raw water from this source undergoes filtration to remove iron and manganese, then chlorination, to disinfect the water and ensure microbiological quality for consumers. The water is also treated with Calgon dosing to reduce its hardness. After treatment, the water is pumped into a nearby storage tank (Figure C4) and distributed via gravity to the town scheme.

Water Corporation's groundwater allocation licence for these bores was last renewed in February 2015, and is due to expire in February 2024. The licence allows the Water Corporation to draw 55 000 kL of water from the Perth Surficial aquifer (unconfined) to supply Watheroo's drinking water from the three production bores.

It should be recognised that although treatment and disinfection are essential barriers against contamination, public drinking water source area (PDWSA) management is the first step in protecting water quality and ensuring a safe drinking water supply. This approach is endorsed by the *Australian drinking water guidelines* (ADWG) (NHMRC & NRMMC 2011) and reflects a preventive risk-based, multiple-barrier approach for providing safe drinking water to consumers. This combination of catchment protection and water treatment will deliver a more reliable, safer and lower cost drinking water to consumers than either approach could achieve individually.

For more information on why it is so important to protect our catchments, read Appendix D.

Aboriginal sites of significance and native title claims

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* protects all Aboriginal sites in the state.

There is one Aboriginal site of significance within the Watheroo Water Reserve. This is Jingemia Hill (S00740). Figure A3 shows the area of Crown reserve within the Watheroo Water Reserve where the Jingemia Hill site of significance is located.

Native title is the recognition in Australian law that some Aboriginal people continue to hold native title rights to lands and water arising from their traditional laws and customs. There is one native title claim within the Watheroo Water Reserve. This is the Yued (WAD6192/98).

The Department of Water is committed to working with Aboriginal people in its planning and management activities. The department recognises that native title is an important framework for water management.

Enforcing by-laws, surveying the area and maintenance

Water Corporation's site operator conducts weekly production bore surveillance and inspections and a catchment ranger conducts bi-annual surveillance of the production bores and catchment. This review recommends that the Water Corporation continue by-law enforcement under the existing delegation arrangement. This includes:

- erecting and maintaining signs in accordance with *S111 Source protection signage* (Water Corporation 2013)
- maintaining security and fencing surrounding the bores and treatment compounds
- ongoing regular surveillance and inspections of the production bores
- reporting of significant incidents through the Advisory Committee for the Purity of Water.

Other Department of Water work

In April 2009 the Department of Water published the *Review of the Jurien and Arrowsmith groundwater allocation limits, Supporting information for the Jurien and Arrowsmith groundwater area allocation plans*. This report outlines the history of allocation for the region and it was prepared to inform the preparation of the *Jurien Groundwater allocation plan* (Department of Water 2010). It includes information about the available groundwater resources in the Watheroo area.

In August 2010 the Department of Water published the *Jurien Groundwater allocation plan*. This plan outlines how water is allocated and managed within the Jurien Groundwater Area (the Watheroo Water Reserve is within the Jurien Groundwater Area). It is used to manage the allocation of groundwater for a variety of uses including, water dependent ecosystems, public water supply, mining and agriculture.

Update on water quality risks

As part of this review, we have conducted a new assessment of water quality contamination risks to the Watheroo drinking water source, in accordance with the ADWG. Table 1 shows a summary of the assessment of the risks to water quality.

Land uses in the Watheroo Water Reserve have remained the same since the 1999 plan. The main land use in the Watheroo Water Reserve is still agriculture, predominantly broadacre cropping and grazing.

The production bores are within secure compounds managed by the Water Corporation. There have been no reported problems of vandalism at the compounds and the Water Corporation conducts weekly inspections of the bore compounds and bi-annual inspections of the Watheroo Water Reserve.

Bores drilled near a public drinking water supply bore (such as for irrigation or private purposes) can cause contamination of the drinking water source. For example, a

poorly constructed 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 Department of Water's water licensing process where applicable under the *Rights in Water and Irrigation Act 1914.* All bores should be constructed in accordance with *Minimum construction requirements for water bores in Australia* (National Minimum Bore Specifications Committee 2012).

Currently there are no other licensed water users within the Watheroo Water Reserve.

Table 1 Summary of potential water quality risks and best management practices

Land use/activity	Hazard	Management priority	Comments	Best management practice guidance[1]
Cropping and grazing	Pathogens from livestock and human activity	Medium	Cropping and grazing occurs in close locality to the fenced production bore compounds	WQPN no. 1: *Agriculture: dryland crops near sensitive water resources*; Public sector circular number 88: *Use of herbicides in water catchment areas*
	Hydrocarbon contamination caused by fuel spills and oil leaks from vehicles and machinery	Low		
	Nutrients from livestock excrement and fertilisers	Low		
	Pesticides, herbicides and chemicals	Medium		
Roads and tracks	Hydrocarbon contamination caused by fuel spills and oil leaks from vehicles	Low	Existing roads and tracks are all on private land so access is controlled	WQPN no. 44: *Roads near sensitive water resources*

[1]Water quality protection notes (WQPNs) are available at drinkingwater.water.wa.gov.au

Water quality information

The Water Corporation has provided updated water quality information for the Watheroo bore field. This is shown in Appendix B.

Raw water from the production bores is considered hard but it has consistently been of good quality. With the exception of iron and manganese, water has generally met the guidelines for drinking water quality in Australia.

Hardness, turbidity, high iron and manganese are naturally occurring and typical of groundwater within the region. These aspects of the water are treated before supply to consumers.

2 Implementation of Watheroo's drinking water source protection plan

Status of previous 1999 source protection plan recommendations

Table 2 outlines recommendations from the 1999 plan and their current status.

Table 2 Implementation status for Watheroo Water Reserve

No.	Recommendation	Status
1	Gazettal of water reserve.	Gazetted in 2002 under the *Country Areas Water Supply Act 1947.*
2	Incorporation into land planning strategies and reflection of the priority 2 area.	The Watheroo Water Reserve was not incorporated into Moora's *Local Planning Scheme no. 4*. This is carried forward as a final recommendation in this review.
3	Referral of development proposals within the water reserve to the Department of Water (formally Water and Rivers Commission).	Applicable development proposals within all PDWSAs are referred to the Midwest Gascoyne Region office of the Department of Water.
4	Signs should be erected along the boundary of the water reserve.	As the PDWSA is almost completely located on private land the Water Corporation has made the decision that catchment signage won't be installed along the entire reserve boundary, however they will be installed along the main access routes and around the bore compounds.
5	Emergency response: • Develop process to address any spillage of pollutants within the water reserve.	Water Corporation has spill response procedures in place. The private landowner, who owns the land on which the production bores are located, has been sent guidance on best management practices for emergency response within public drinking water source areas; WQPN no. 10: *Contaminant spills – emergency response*.

No.	Recommendation	Status
6	Surveillance program put in place to identify incompatible land uses or potential contaminant threats within the water reserve.	Water Corporation undertakes regular surveillance within the water reserve.
7	Monitor nutrient and pesticide levels in production bores.	Water Corporation undertakes ongoing monitoring of nutrients, pesticides and pathogens as part of the drinking water quality monitoring program.
8	Review implementation of recommendations a year after publication and review plan approximately every seven years.	Undertaken through the preparation of this review document. Regular reviews have been incorporated as a final recommendation in this document.

Consolidated recommendations

Based on the findings of this review, the following recommendations will now be applied to the Watheroo Water Reserve. The bracketed stakeholders are those expected to have a responsibility for, or an interest in, the implementation of that recommendation.

1. Incorporate the findings of this plan and location of the Watheroo Water Reserve (including its priority areas and protection zones) in the Moora local planning scheme in accordance with the Western Australian Planning Commission's State planning policy no. 2.7: *Public drinking water source policy*. (Shire of Moora)
2. Water Corporation should continue the current regime of water quality monitoring, maintenance, surveillance, inspections and by-law enforcement. (Water Corporation)
3. Install catchment signage along the main access routes and around the bore compounds. (Water Corporation)
4. Provide the private landowner, who owns the land on which the production bores and wellhead protection zones are located, with relevant best management practice guidance documents. (Department of Water)
5. Conduct a groundwater assessment to improve the accuracy of the Watheroo Water Reserve boundary. Include updated boundary into the next review. (Department of Water)
6. Update this plan after seven years. This may require a new plan if significant changes have occurred. (Department of Water)

Appendices

Appendix A — Figures

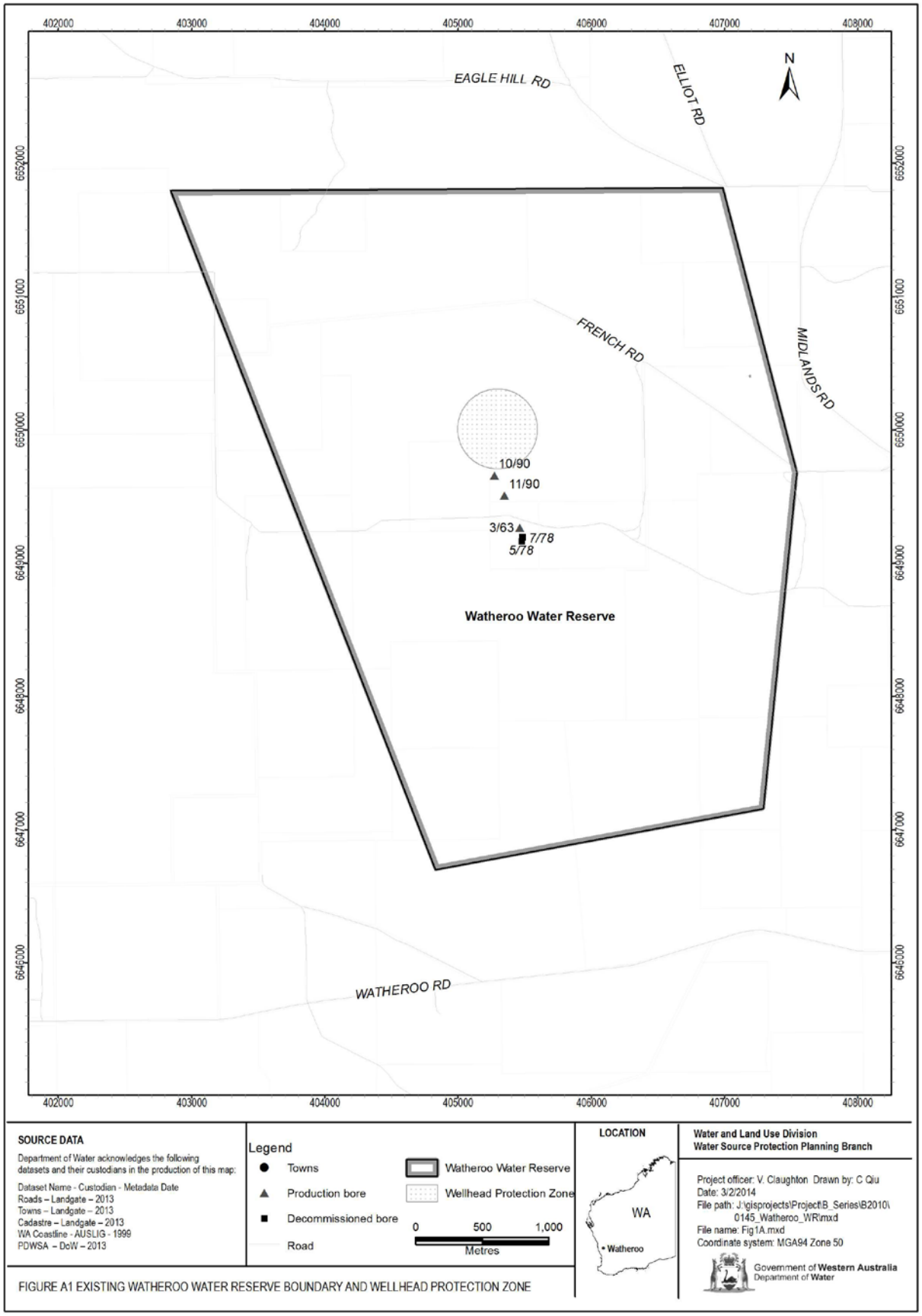
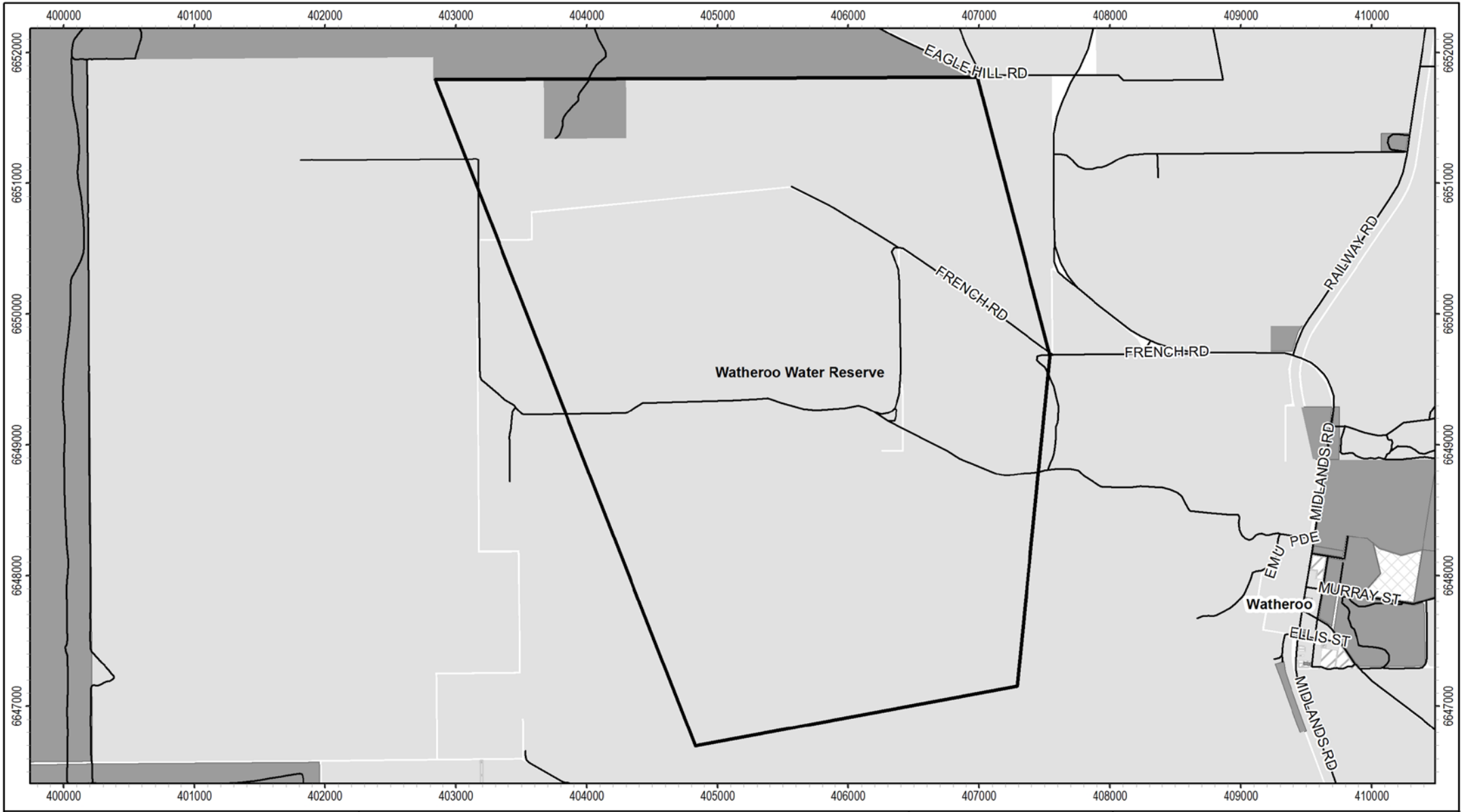


FIGURE A1 EXISTING WATHEROO WATER RESERVE BOUNDARY AND WELLHEAD PROTECTION ZONE



SOURCE DATA

Department of Water acknowledges the following datasets and their custodians in the production of this map:

Dataset Name – Custodian – Metadata Date
Roads – Landgate – 2012
Cadastre – Landgate – 2012
PDWSA – DoW – 2013

LEGEND

- Towns
- Roads
- Watheroo Water Reserve

Cadastre, Land Tenure

- Crown Lease
- Crown Reserve
- Freehold
- Unallocated Crown Land

N

0 0.5 1
Kilometres

LOCATION

Water and Land Use Division
Water Source Protection Planning Branch

Project officer: V. Claughton Drawn by: C Qiu
Date: 26/11/2013
File path: J:\gisprojects\Project\B_Series\B2010\0145_Watheroo_WR\mxd
File name: Fig2.mxd
Coordinate system: MGA94 Zone 50

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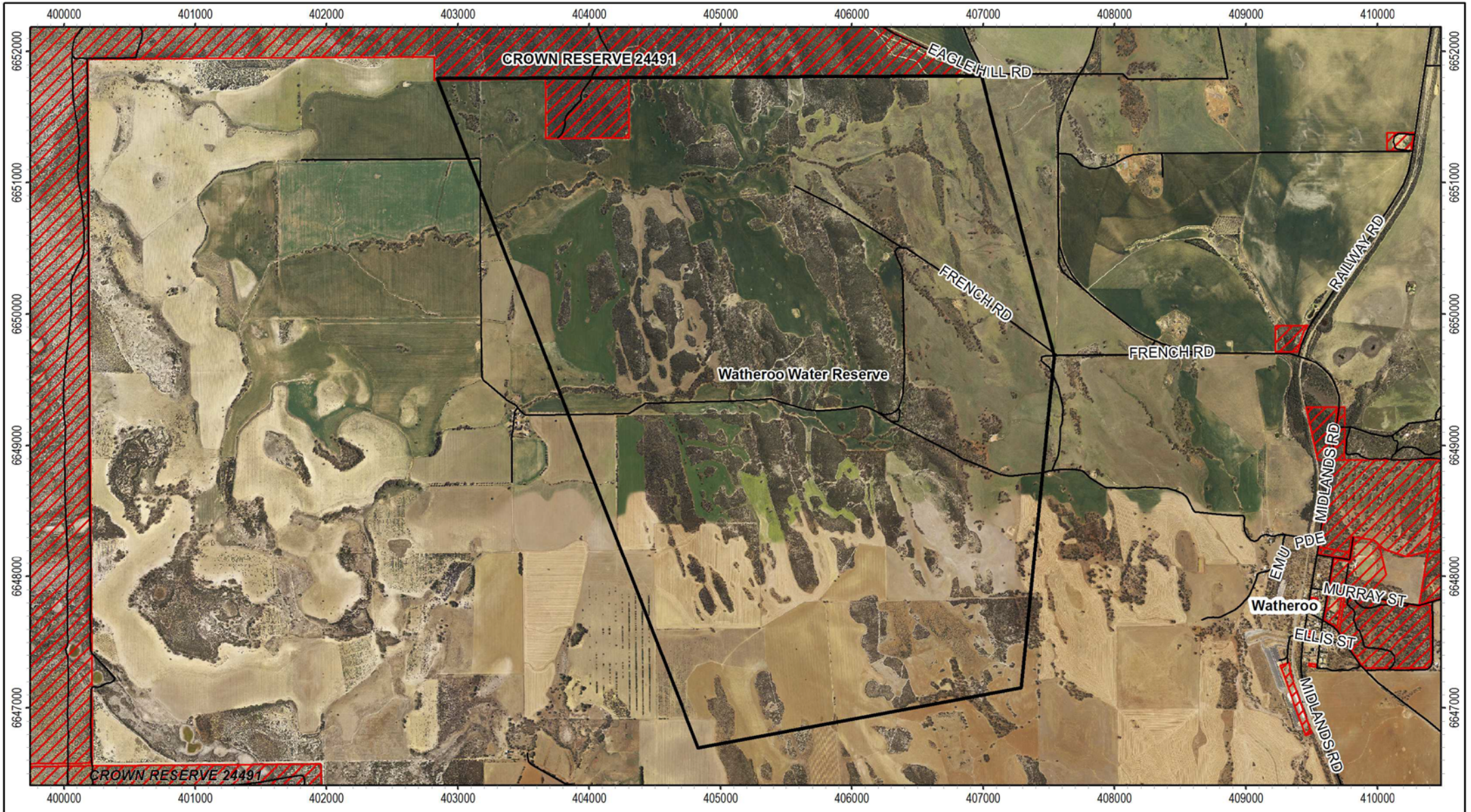
FIGURE A2 LAND USE, ACTIVITIES AND TENURE IN AND AROUND THE WATHEROO WATER RESERVE



SOURCE DATA

Department of Water acknowledges the following datasets and their custodians in the production of this map:

Dataset Name – Custodian – Metadata Date
Roads – Landgate – 2012
Cadastre – Landgate – 2012
PDWSA – DoW – 2013
Watheroo_2010_50cm_z50 – Landgate – 2010

LEGEND

- Towns
- Roads
- Existing Watheroo Water Reserve

Cadastre, Land Tenure

- Crown Reserve

N

0 0.5 1

Kilometres

LOCATION

Water and Land Use Division
Water Source Protection Planning Branch

Project officer: V. Claughton Drawn by: C Qiu
Date: 26/11/2013
File path: J:\gisprojects\Project\B_Series\B2010\0145_Watheroo_WR\mxd
File name: Fig3.mxd
Coordinate system: MGA94 Zone 50

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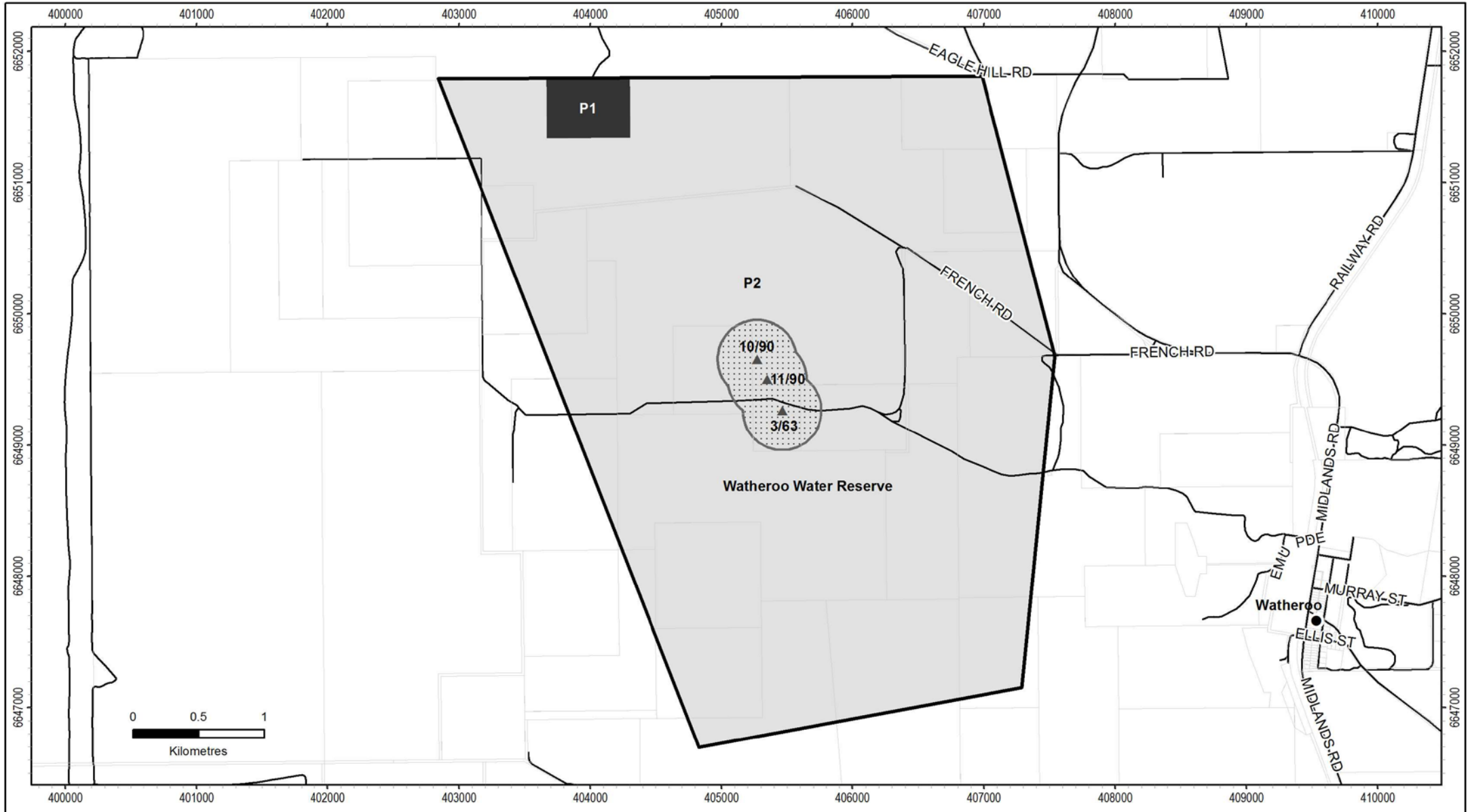
FIGURE A3 AERIAL PHOTOGRAPHY AND LAND USES IN WATHEROO WATER RESERVE



SOURCE DATA

Department of Water acknowledges the following datasets and their custodians in the production of this map:

Dataset Name – Custodian – Metadata Date
Roads – Landgate – 2013
Cadastre – Landgate – 2013
PDWSA – DoW – 2013

LEGEND

- Towns
- Production bores
- Roads
- Cadastre
- Watheroo Water Reserve
- Wellhead Protection Zone
- proposed Priority one (P1) area
- Priority two (P2) area

N

LOCATION

Water and Land Use Division
Water Source Protection Planning Branch

Project officer: V. Claughton Drawn by: C Qiu
Date: 3/2/2014
File path: J:\gisprojects\Project\B_Series\B2010\0145_Watheroo_WR\mxd
File name: Fig4B.mxd
Coordinate system: MGA94 Zone 50

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FIGURE A4 PROPOSED BOUNDARY, PRIORITY AREAS AND WELLHEAD PROTECTION ZONES OF THE WATHEROO WATER RESERVE

Appendix B — Water quality data

The Water Corporation has monitored the raw (source) water quality from Watheroo in accordance with the requirements of the *Australian drinking water guidelines*, 2011 (ADWG) and interpretations agreed to with the Department of Health. This data shows the quality of water in the catchment. The raw water is regularly monitored for:

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

The following data represents the quality of raw water from Watheroo bore field. In the absence of specific guidelines for raw water quality, the results have been compared with the ADWG values set for drinking water, which defines the quality requirements at the customer's tap. Any water quality parameters that have been detected are reported; those that on occasion have exceeded the ADWG are in bold and italics to give an indication of potential raw water quality issues associated with this source. The values are taken from ongoing monitoring for the period January 2008 to December 2013.

It is important to appreciate that the raw water data presented does not represent the quality of drinking water distributed to the public. Barriers such as storage and water treatment exist downstream of the raw water to ensure it meets the requirements of the ADWG.

For more information on the quality of drinking water supplied to the Mid West Region refer to the most recent Water Corporation drinking water quality annual report at watercorporation.com.au.

Aesthetic

The aesthetic water quality analyses for raw water from Watheroo bore field are summarised in the following table.

Aesthetic detections for Watheroo

Parameter	**Units**	**ADWG aesthetic guideline value***	**Watheroo bore field raw water**	
			Range	**Median**
Chloride	mg/L	250	135–180	160
Colour – true	TCU	15	1–8	4
Hardness as $CaCO_3$	mg/L	200	***220–260***	***230***
Iron (unfiltered)	mg/L	0.3	0.08–***5.6***	***0.9***
Manganese (unfiltered)	mg/L	0.1	0.03–***0.2***	***0.18***
Silicon as SiO_2	mg/L	80	7.9–15	13
Sodium	mg/L	180	61–90	83
Sulfate	mg/L	250	13–16	14
Total filterable solids	mg/L	600	516–***603***	570
Turbidity	NTU	5	0.2–***37***	4.2
pH (lab)	pH units	6.5 –8.5	6.94–7.54	7.23

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

Health-related

Health-related chemicals

Raw water from Watheroo bore field is analysed for chemicals that are harmful to human health including inorganics, heavy metals, industrial hydrocarbons and pesticides. Health-related parameters that have been detected in the source are summarised in the following table.

Health-related detections for Watheroo

Parameter	Units	ADWG health guideline value*	Watheroo bore field raw water	
			Range	Median
Manganese (unfiltered)	mg/L	0.1	0.03–***0.2***	***0.18***
Nitrite plus nitrate as N	mg/L	11.29†	<0.002–0.11	<0.05
Sulfate	mg/L	500	13–16	14
Barium	mg/L	0.7	0.01–0.013	0.012
Boron	mg/L	4	0.08–0.09	0.085
Fluoride (lab)	mg/L	1.5	<0.10–0.1	<0.1

* 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, 2011).

† The guideline value of 11.29 mg/L (as nitrogen) has been set to protect bottle fed infants less than three months of age. Up to 22.58 mg/L (as nitrogen) can be safely consumed by adults and children over three months of age.

Microbiological contaminants

Microbiological testing of raw water samples from Watheroo bore field 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 *E. coli* in raw water abstracted from any bore may indicate contamination of faecal material through ingress into the bore, or recharge through to the aquifer (depending on aquifer type).

During the review period, positive *E. coli* counts were recorded in 2.4 per cent of samples.

Appendix C — Photographs

Figure C1 Watheroo Water Reserve production bore 11/90 in a secure compound

Figure C2 Cropping and sheep grazing in the Watheroo Water Reserve

Figure C3 Secure compound within the Watheroo Water Reserve that contains production bore 3/63, the water treatment plant and decommissioned bores 5/78 and 7/78

Figure C4 Water storage tank for the Watheroo water supply

Appendix D — Typical contamination risks in groundwater sources

Land development and land- or water-based activities within a water reserve can directly affect the quality of drinking water and its treatment. Contaminants can reach drinking water sources through runoff over the ground and infiltration through soil. A wide range of microbiological, chemical and physical contamination risks can impact on water quality and therefore affect the provision of safe, good quality drinking water to consumers.

Some contaminants in drinking water can affect human health, resulting in illness, hospitalisation or even death. Other impurities can affect the water's aesthetic qualities, including its appearance, taste, smell and 'feel' but are not necessarily hazardous to human health. For example, cloudy water with a distinctive odour or strong taste may not be harmful to health, but clear, pleasant-tasting water may contain harmful, undetectable microorganisms (NHMRC & NRMMC 2011). Contaminants can also interfere with water treatment processes, and damage water supply infrastructure (such as iron corroding pipes).

The ADWG (NHMRC & NRMMC 2011) outlines criteria for acceptable drinking water quality to protect human health, manage aesthetics and maintain water supply infrastructure.

Some commonly seen contamination risks relevant to groundwater drinking water sources are described below.

Microbiological risks

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

Pathogens can enter drinking water supplies from faecal contamination in the water reserve. In groundwater sources, this occurs indirectly – faecal material can infiltrate through the soil and into the groundwater. For example, contamination can occur from septic tanks or grazing animals.

A number of pathogens are commonly known to contaminate water supplies worldwide. These include bacteria (for example *Salmonella*, *Escherichia coli* and cholera), protozoa (such as *Cryptosporidium* and *Giardia*) and viruses. Monitoring for the presence of *E. coli* in water supplies provides an indication of the level of recent faecal contamination.

Pathogen contamination of a drinking water source is influenced by many factors including the existence of pathogen carriers (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).

The survival and movement of pathogens in groundwater is influenced by the characteristics of the pathogen (such as its size and the length of time it normally takes to decay) and the groundwater properties (including flow rate, permeability, amount of carbon in the soil, temperature and pH). Inactivation rate (the time it normally takes a pathogen to decay) is one of the most important factors governing how far pathogens may migrate. Typical half-lives of pathogens range from a few hours to a few weeks. For example, some reported migration distances of bacteria in groundwater are:

- 600 m in a sandy aquifer
- 1000–1600 m in channelled limestone
- 250–408 m in glacial silt-sand aquifers (Robertson & Edbery 1997).

Unlike chemicals, which dissipate and dilute when they enter a water source, pathogens can multiply under the right conditions, increasing the likelihood of contamination. Therefore it is important to understand both the surface water and groundwater systems to be able to protect the drinking water source from pathogens.

When people consume drinking water contaminated with pathogens the consequences 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's water supply was contaminated by a pathogenic strain of *E. coli* and *Campylobacter* (NHMRC & NRMMC 2011).

Given the wide variety of pathogens, the differences in how they act in the environment and the potential consequences of consuming contaminated water, the most effective way to protect public health and reduce water treatment costs is to avoid the introduction of pathogens into a water source.

Physical risks

Turbidity is the result of soil or organic particles becoming suspended in water (cloudiness). Increased turbidity can result in cloudy or muddy-looking water, which is not aesthetically appealing to consumers. Turbidity can also reduce the effectiveness of treatment processes (such as disinfection). This is because pathogens can adsorb onto soil particles and may be shielded from the effects of disinfection. Chemicals can also attach to suspended soil particles.

Some physical properties of water such as pH (a measure of acidity or alkalinity) can contribute to the corrosion and encrustation of pipes. Other properties such as iron and dissolved organic matter can affect the colour and smell of water. Although not necessarily harmful to human health, coloured or 'hard' water will not be as appealing to consumers. Salinity can affect the taste of drinking water.

Chemical risks

Chemicals can occur in drinking water as a result of natural leaching from mineral deposits or from different land uses (NHMRC & NRMMC 2011). 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 these cases, the relevant authorities should be notified promptly and the spill cleaned up to prevent contamination of the drinking water source.

Hydrocarbons (such as fuels and 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.

Drinking water sources can also be contaminated by nutrients (such as nitrogen) from fertiliser, septic systems, and faecal matter from domestic or feral animals that washes through or over soil and into a water source. Nitrate and nitrite (forms of nitrogen) can be toxic to humans at high levels, with infants younger than three months being most susceptible (NHMRC & NRMMC 2011).

Other chemicals and heavy metals can be associated with land uses such as industry and landfill. These may enter drinking water sources and could be harmful to human health.

Appendix E — How do we protect public drinking water source areas?

The *Australian drinking water guidelines* (ADWG) (NHMRC & NRMMC 2011) outline how we should protect drinking water in Australia. The ADWG recommends a 'catchment to consumer' framework that uses a preventive risk-based and multiple-barrier approach. A similar approach is recommended by the World Health Organization.

The catchment to consumer framework applies across the entire drinking water supply system – from the water source to the taps in your home. It ensures a holistic assessment of water quality risks and solutions to ensure the delivery of a reliable and safe drinking water to supply your home.

A preventive risk-based approach means that we look at all the different risks to water quality. We determine what risks can reasonably be avoided and what risks need to be minimised or managed to protect public health. This approach means that the inherent risks to water quality are as low as possible. A multiple-barrier approach means that we use different barriers against contamination at different stages of a drinking water supply system.

The first and most important barrier is protecting the public drinking water source area (PDWSA) (the area from which water is captured to supply drinking water). If we get this barrier right, it has a flow-on effect that can result in a lower cost, safer drinking water supply. Other barriers against contamination include storage of water to help reduce contaminant levels, disinfecting the water (for example chlorination to inactivate pathogens), maintenance of pipes and testing of water quality. Another community benefit from PDWSA protection is that it complements the state's conservation initiatives.

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. We should not forget that ultimately it's about protecting your health by protecting water quality now and for the future.

In Western Australia, the Department of Water protects PDWSAs by implementing the ADWG, writing reports, policies and guidelines, and providing input into land-use planning.

This drinking water protection report achieves elements 2 and 3 of the 12 elements in the ADWG recommended for protecting drinking water. It shows the PDWSA's location, its characteristics, existing and potential water quality contamination risks, and makes recommendations to deal with those risks.

The *Metropolitan Water Supply, Sewerage, and Drainage Act 1909* and the *Country Areas Water Supply Act 1947* provide us with important tools to protect water quality in proclaimed PDWSAs. These Acts allow us to assess and manage the water quality contamination risks from different land uses and activities. The department works

cooperatively with other agencies and the community to implement this legislation and develop drinking water source protection reports. For example, the Western Australian Planning Commission has developed a number of state planning policies to help guide development in PDWSAs.

An important step in maximising the protection of water quality in PDWSAs is to define their boundaries, priority areas and protection zones to help guide land-use planning and to identify where legislation applies. There are three different priority areas. The objective of priority 1 (P1) areas is risk avoidance – ensuring there is no degradation of the water quality (for example over Crown land). The objective of priority 2 (P2) areas is risk minimisation – maintaining or improving water quality (for example over rural-zoned land). The objective of priority 3 (P3) areas is risk management – maintaining the water quality for as long as possible (for example, urban- or commercial-zoned land). Protection zones surround drinking water abstraction bores and surface water reservoirs so that the most vulnerable areas are protected from contamination.

With 129 proclaimed PDWSAs across Western Australia, the department prioritises the update of drinking water source protection reports (such as this document). Our aim is to update each report every seven years. In some locations, more frequent updates may be required to address changing water quality risks and land uses. These updates allow us to make changes to the PDWSA boundary, priority areas and protection zones if required. They also allow solutions to new water quality risks to be considered.

There are three different types of drinking water source protection report – each providing for different needs. The following table shows the differences between the types of reports.

There is a fourth type of report – Land use and water management strategy – that performs the same functions as a drinking water source protection report. However, these strategies are prepared by the Western Australian Planning Commission (with input from the Department of Water) and are strategic documents that integrate land use planning with water management. There are currently land use and water management strategies for Gnangara, Jandakot and Middle Helena.

If you would like more information about the ADWG and how we protect drinking water in Western Australia, visit drinkingwater.water.wa.gov.au or refer to our Water quality protection note (WQPN) no. 36: *Protecting public drinking water source areas*. You can also contact the Department of Water's Water source protection planning branch on +61 8 6364 7600 or email drinkingwater@water.wa.gov.au.

Drinking water source protection reports produced by Department of Water

Drinking water source protection report	**Scope and outcome**	**Consultation**	**Time to prepare**	**Implementation table**	**Proclamation**
Drinking water source protection assessment (DWSPA)	Desktop assessment of readily available information.	Targeted	Up to 3 months	No	Proclamation to protect water quality and guide land use planning can occur as a result of any type of drinking water source protection report.
Drinking water source protection plan (DWSPP)	Full investigation of risks to water quality building on information in the DWSPA.	Public	6–12 months	Prepared from recommendations in the DWSPA and/or information from public consultation.	
Drinking water source protection review (DWSPR)	Review change in land and water factors and implementation of previous recommendations. Sometimes prepared to consider specific issues in a PDWSA.	Key stakeholders	Up to 3 months	Prepared from recommendations in the DWSPA or DWSPP.	

Appendix F — Understanding risks to drinking water quality

The existing integrated land use planning and public drinking water source area (PDWSA) protection program is based on the findings of three parliamentary committee reports in 1994, 2000 and 2010 (see *Further reading*). Since 1995, this integrated program has resulted in the development of four Western Australian Planning Commission state planning policies. These planning policies recognise the importance of PDWSAs for the protection of water quality and public health.

This integrated program relies upon a preventive risk-based assessment process in each PDWSA through the development of drinking water source protection reports. It is important to understand how risks are assessed to appreciate the impact of development within PDWSAs.

Risk-based assessments normally focus on the acceptability of risks after mitigation (residual risks). For drinking water sources, a preventive risk-based assessment that considers both the maximum and residual risks is required. This means that in some cases, the maximum risks from land uses will still be considered unacceptable, even after mitigation has reduced the risk. This is a more conservative approach needed to protect the health of consumers.

Water quality risks are evaluated by considering the type and scale of a potential contamination event (consequence), together with the probability/frequency of that event occurring (likelihood). An understanding of this relationship will prevent the common misunderstanding that probability equals risk (see risk matrix below).

For example, just because a drinking water contamination incident has not occurred for many years (low likelihood) does not mean that the risk is low, because we also need to consider the consequence of that contamination when determining risk. Further, no previous detection of contamination is not proof that the risk is acceptable.

Risk matrix: Level of risk (from the Australian drinking water guidelines *2011)*

Likelihood	**Consequences**				
	Insignificant	**Minor**	**Moderate**	**Major**	**Catastrophic**
Almost certain	Moderate	High	Very high	Very high	Very high
Likely	Moderate	High	High	Very high	Very high
Possible	Low	Moderate	High	Very high	Very high
Unlikely	Low	Low	Moderate	High	Very high
Rare	Low	Low	Moderate	High	High

List of shortened forms

ADWG	*Australian drinking water guidelines*
ANZECC	Australian and New Zealand Environment Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
kL	kilolitre
km	kilometre
m	metres
mg/L	milligram per litre
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
TCU	true colour units
WHPZ	wellhead protection zone
WQPN	water quality protection note

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.
Aesthetic guideline value	The concentration or measure of a water quality characteristic that is associated with acceptability of water to the consumer, for example appearance, taste and odour (NHMRC & NRMMC 2011).
Allocation	Is the volume of water that a licensee is permitted to abstract, usually specified in kilolitres per annum (kL/a).
Aquifer	An aquifer is a geological formation or group or 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*, 2011 (NHMRC & NRMMC 2011) (ADWG) outlines acceptable criteria for the quality of drinking water in Australia (see this plan's References).
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 area of land which intercepts rainfall and contributes the collected water to surface water (streams, rivers, wetlands) or groundwater.
Drinking water source protection report	A report on water quality hazards and risk levels within a public drinking water source area; includes recommendations to avoid, minimise, or manage those risks for the protection of the water supply in the provision of safe drinking water supply.
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 2011).
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.

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 something (such as salinity) in a solution.
Nephelometric turbidity units	Nephelometric turbidity units are a measure of turbidity in water.
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.
Permeability	The ability of a porous medium to transmit a fluid
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.
Public drinking water source area	The area from which water is captured to supply drinking water. It includes all underground water pollution control areas, catchment areas and water reserves constituted under the *Metropolitan Water Supply, Sewerage, and Drainage Act 1909* or the *Country Areas Water Supply Act 1947*.
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.

Surficial	Geology of or relating to the surface of the earth.
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. This is also known as a superficial aquifer.
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* or the *Metropolitan Water Supply, Sewerage, and Drainage Act 1909* for the purposes of protecting a drinking water supply.
Watertable	The upper saturated level of the unconfined groundwater is referred to as the watertable.
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 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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