

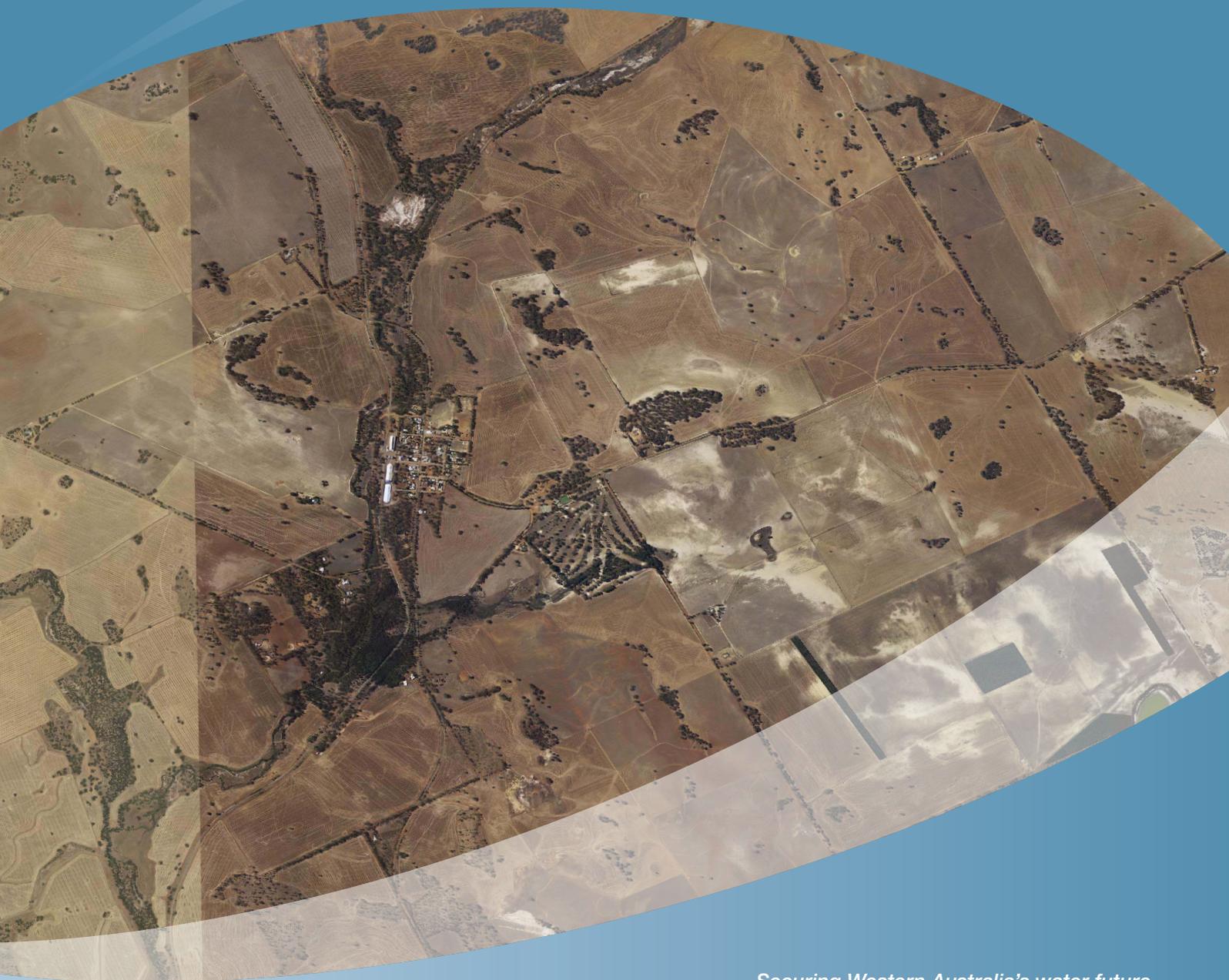


Government of Western Australia
Department of Water

Bolgart Water Reserve

Drinking water source protection plan

Bolgart town water supply



Securing Western Australia's water future

Water resource protection series
Report WRP 158
April 2016

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Department of Water

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Report no. WRP 158

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ISSN 1835-3924 (online)

ISBN 978-1-925174-27-4 (online)

Acknowledgements

The Department of Water would like to thank the following for their contribution to this publication: Kathryn Buehrig, Alex Kern, Chris Qiu, Stephen Watson and Nigel Mantle (Department of Water) and Michael Sawyer (Water Corporation).

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Summary

Bolgart is located in the Wheatbelt region of Western Australia, about 120 km north-east of Perth. The town's drinking water is supplied by the Water Corporation from two wellfields containing one unconfined (shallow) bore each:

- Bull Road wellfield, located about 1 km to the east of town
- Western wellfield, located about 750 m to the west of town.

Both bores are located in secure compounds owned by the Water Corporation. The wellfields are surrounded by private farming land, with the main land uses being grazing and cropping. As the groundwater source is unconfined, Bolgart's drinking water is vulnerable to contamination from surrounding land uses. The main risks identified are contamination from a landfill, pathogens from septic tanks and grazing; nutrients from fertilisers; hydrocarbons from farm machinery and vehicles; and chemicals from pesticides.

This drinking water source protection plan considers changes that have occurred in and around the Bolgart Water Reserve since completion of the *Bolgart Water Reserve water source protection plan* (Water and Rivers Commission 1999), and replaces it.

We prepared this document in consultation with key stakeholders, including land owners and local councillors, Water Corporation, Department of Planning, Department of Health, Department of Environment Regulation, Department of Mines and Petroleum and the shires of Victoria Plains and Toodyay.

The main changes since the 1999 plan are:

- The Bolgart Water Reserve boundary is proposed to change to reflect a better understanding of the hydrogeology of the area, but the overall size will remain similar.
- The 1999 plan discussed developing and proclaiming a third wellfield (Wattening/South Eastern Water Reserve) but in 2001 this was identified as being surplus to drinking water supply requirements.
- The 1999 plan included several other bores (5/63, 7/67 and 6/63) which have since been decommissioned, therefore wellhead protection zones are no longer required for these.
- The Bolgart landfill now falls partially within the Bolgart Water Reserve boundary, posing a risk to Bolgart's drinking water quality.
- Recommendations from the 1999 plan have now been completed.

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

Table 1 shows important information about the Bolgart Water Reserve.

Table 1 Key information about the Bolgart Water Reserve

Bolgart Water Reserve	
Status of this report	This report has been prepared based on information for the 2014/15 financial year
Local government authorities	Shire of Victoria Plains, Shire of Toodyay
Location supplied	Bolgart
Water service provider	Water Corporation
Aquifer type	Unconfined
Licensed abstraction	40 000 kL/year
Number of bores	2
Bore names and GPS coordinates	1/96, Western wellfield (E 452451, N 6539783, zone 50) 6/81, Bull Road wellfield (E 454448, N 6539416, zone 50)
Date of bore completion	1/96 – 1996 6/81 – 1981
Dates of drinking water source protection reports	1999 – Bolgart Water Reserve water source protection plan (Water and Rivers Commission) 2016 – Bolgart Water Reserve drinking water source protection plan (this document)
Consultation	1999 – consultation as part of the water source protection plan 2015 – landowner mailout and key stakeholder consultation
Proclamation history	Bolgart Water Reserve was proclaimed 24 September 2004 under the <i>Country Areas Water Supply Act 1947</i> , including the Western wellfield and the Bull Road wellfield. An amended boundary will need to be proclaimed under the <i>Country Areas Water Supply Act 1947</i> once this plan is finalised.
Reference documents	<i>Australian drinking water guidelines</i> (NHMRC & NRMCC 2011) State planning policy no. 2.7: <i>Public drinking water source</i>

Bolgart Water Reserve	
	<i>policy</i>

1 Overview of Bolgart's drinking water source protection

Bolgart is located in the Wheatbelt region of Western Australia, about 120 km north-east of Perth, in the Shire of Victoria Plains (Figure A1). The town services local rural agriculture, predominantly based on wheat farming and stock grazing. Bolgart's rail siding provides a collection point for transporting grain. The town has a population of approximately 100 people.

1.1 Drinking water supply scheme

The Water Corporation supplies Bolgart's drinking water from two wellfields; the Western wellfield (about 750 m west of town) and the Bull Road wellfield (about 1 km east of town). The wellfields occupy discrete depressions about 2 km apart.

Each wellfield has one production bore and one monitoring bore. The Western wellfield production bore is 1/96 and the Bull Road wellfield production bore is 6/81 (Figure A2). The previous plan (Water and Rivers Commission 1999) included several other bores (5/63, 7/67 and 6/63) which have since been decommissioned, although 5/63 continues to be used for monitoring.

Bore 1/96 is screened from 15.3 m to 18.3 m deep, and bore 6/81 is screened from 12.45 m to 16.9 m deep. Both bores draw water from an unconfined aquifer, which means that Bolgart's drinking water source is vulnerable to contamination from surrounding land uses.

Raw water from the production bores is pumped to Bolgart East treatment plant, where it is blended and chlorinated prior to being stored in the adjacent 225 kL ground-level tank. From there, it gravitates into the town reticulation system. There are 42 water service units in Bolgart.

The water from each wellfield needs blending because of the high salinity levels at the Bull Road wellfield. Blending occurs at a ratio of one to one between the wellfields. Blending commenced in January 2004 after infrastructure upgrades (Water Corporation 2011).

It should be recognised that although treatment and disinfection are essential barriers against contamination, public drinking water source area 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 & NRMCC 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 E.

1.1.1 Groundwater abstraction licence

Bolgart's drinking water is sourced from the Bolgart Groundwater Area (for the Western wellfield) and the Bolgart East Groundwater Area (for the Bull Road wellfield), and both areas are proclaimed under the *Rights in Water and Irrigation Act 1914*. This means that groundwater abstraction requires a licence from the Department of Water. These groundwater areas are not fully allocated.

The Water Corporation is licensed by the Department of Water to abstract up to 40 000 kL of groundwater per year for public drinking water supply, under licence no. 65087(5), which expires in 2017. Total abstraction for Bolgart's drinking water supply from October 2013 to September 2014 was 19 078 kL, well within the Water Corporation's licensed allocation limit of 40 000 kL per year (Water Corporation 2014). This is slightly higher than previous years, with 16 951 kL abstracted during 2012/13 and 18 892 kL abstracted during 2011/12.

At current and future predicted levels of abstraction, the aquifer is considered to have adequate capacity to meet future drinking water demands (Water Corporation 2010).

1.1.2 Future water needs

The Water Corporation has identified that the existing Bolgart bores have adequate capacity to supply Bolgart for the foreseeable future.

The *Bolgart Water Reserve water source protection plan* (Water and Rivers Commission 1999) discussed a future third wellfield – Wattening/South Eastern Water Reserve – but in 2001, the Water Corporation identified this wellfield as surplus to Bolgart's future drinking water needs, so it was never proclaimed.

1.1.3 Non-potable emergency source

Bolgart has community emergency water supply (non-potable), located just to the east of town, provided through the establishment of a soak and installation of storage tanks. This will reduce pressure on the drinking water supply scheme because the water can be used for stock watering during dry periods, fire fighting and townscape irrigation (*Central Midlands & Coastal Advocate* 3 July 2014, p. 4).

The soak is located to the south of town, outside of the Bolgart Water Reserve. It is also outside of the *Rights in Water and Irrigation Act 1914* area, so it does not require a licence from the Department of Water.

1.2 Characteristics of the Bolgart Water Reserve

1.2.1 Climate

Bolgart experiences a Mediterranean-type climate with hot, dry summers and cool, wet winters. Most rain results from winter cold front systems. The annual rainfall for Bolgart in 2014 was 378 mm, which is lower than the long-term average of 452 mm (Bureau of Meteorology 2015).

1.2.2 Hydrogeology

The Department of Water undertook an assessment of hydrogeology in 2014. This section discusses the results of that investigation.

The topography of the area is gently undulating. The crest of the water divides is a remnant of an old surface, continuous with that of the sandplain country to the east. The residual sand from the high-level plains drapes down the drainage slopes and may contain seeps during winter. The Western wellfield is located in a small catchment sloping to the south-east, while the Bull Road wellfield is located in a wider catchment sloping gently to the south-west.

Crystalline rocks of the Yilgarn Craton underlie the Bolgart area. These consist of granite, gneiss, schist and quartzite that are intruded by various mafic and felsic dykes and quartz veins (Wilde and Low 1978, Laws 1980). The basement is overlain by a weathered profile consisting of kaolinite clay, sandy clay and sand, and is covered by laterite on the hills, and locally by residual sand on the slopes.

In the Bolgart area, the residual sand is unconsolidated and up to 30 m thick, possibly occupying depressions within the weathered profile.

Groundwater in the Bolgart area is found predominantly in residual sand and underlying fractured and weathered bedrock. Most of the rainfall is lost through evapotranspiration and surface runoff. Only a small proportion of the rain infiltrates and percolates downwards to recharge the groundwater system.

The sandy aquifer is considered to be unconfined because there is no upper confining layer. This means that Bolgart's drinking water source is vulnerable to contamination from overlying and surrounding land uses.

This hydrogeological investigation has led to the Department of Water recommending a new boundary for the Bolgart Water Reserve to better protect Bolgart's drinking water supply (section 1.3 and Figure A2). The use of travel time was investigated as a tool for determining a boundary, however this resulted in significantly larger boundaries that were not considered necessary to apply. Therefore, the new boundary has been based on the surface catchment boundary for both the Western and Bull Road wellfields.

1.3 Boundary, priority areas and protection zones

The Bolgart Water Reserve was proclaimed on 24 September 2004 under the *Country Areas Water Supply Act 1947*. This provided protection for the Western and Bull Road wellfields. The water reserve boundary included wellhead protection zones (WHPZs) and was assigned a priority 2 (P2) area (Figure A2) in accordance with the scheme zoning and existing farming land uses. The existing water reserve is mostly within the Shire of Victoria Plains, with the southern section of the Bull Road wellfield falling within the Shire of Toodyay.

The boundary for the Bolgart Water Reserve was originally based on topographic contours for the surface catchment and extended to follow cadastral boundaries

where practical (Figure A2). In 2014, the Department of Water conducted a hydrogeological assessment of the Bolgart area (see section 1.2.2 *Hydrogeology*), so we now have a better understanding of the way the groundwater moves through the landscape. As a result, a new boundary has been prepared (Figure A2), which will need to be amended under the *Country Areas Water Supply Act 1947*, after this report is finalised. The new boundary is very similar in size to the existing boundary. The Shire of Victoria Plains should incorporate the new boundary into their local planning scheme (see section 4.2, recommendation no. 2).

The proposed new Bolgart Water Reserve will remain as a P2 area. The WHPZs will remain as a 300 m radius around each bore, but will be slightly adjusted to align with accurate bore locations, and will only surround the bores that are currently being used to supply drinking water (1/96 and 6/81). Figure A5 shows the new boundary, P2 area and WHPZs.

The 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 E.

1.4 Enforcing by-laws, surveying the area and maintenance

This plan recommends that the Water Corporation continues by-law enforcement under the existing delegation arrangement (see section 4.2, recommendation no. 6). This includes:

- erecting and maintaining signs in accordance with *S111 Source protection signage* (Water Corporation 2013)
- maintaining security and fencing surrounding the bores and access roads
- ongoing regular surveillance and inspections.

Signs have been installed on the bore compounds by the Water Corporation (see figures C3 and C6).

1.5 Responding to emergencies

The escape of contaminants during unforeseen incidents and the use of chemicals during emergency responses can result in water contamination. The Shire of Victoria Plains and Shire of Toodyay local emergency management committees (LEMCs), should be familiar with the location and purpose of the Bolgart Water Reserve. An updated locality plan will 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 Bolgart 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 Bolgart

Water Reserve. These personnel should have an adequate understanding of the potential impacts of spills on this drinking water source.

2 Common risks to drinking water quality

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 a reliable, safe, good quality drinking water to consumers.

Some contaminants in drinking water can affect human health. 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 micro-organisms that are undetectable by sight, taste or smell (NHMRC & NRMCC 2011). Contaminants can also interfere with water treatment processes, and damage water supply infrastructure (such as iron corroding pipes).

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

For more information about water quality in this public drinking water source area (PDWSA), see section 3: *Contamination risks in this drinking water source*.

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

2.1 Microbiological risks

Pathogens are types of micro-organisms 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 via faecal material infiltrating 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 (e.g. *Salmonella*, *Escherichia coli* and cholera), protozoa (e.g. *Cryptosporidium*, *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 (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).

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, porosity, 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 & NRMCC 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.

2.2 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 which shield them from the effects of disinfection. Chemicals can also attach to soil particles suspended in water.

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.

2.3 Chemical risks

Chemicals can occur in drinking water as a result of natural leaching from mineral deposits or from different land uses (NHMRC & NRMCC 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 (e.g. 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 fertilisers, 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 & NRMCC 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.

3 Risks to Bolgart's drinking water quality

As part of this plan, the Department of Water has conducted a new assessment of water quality contamination risks to Bolgart's drinking water source in accordance with the ADWG. This section describes the risks, and Table 2 displays a summary.

Refer to Appendix D for information about typical contamination risks in groundwater PDWSAs and to Appendix F to gain a greater understanding about the risk assessment process we use.

3.1.1 Bore compounds

Bolgart's two public drinking water supply bores are located inside secure compounds that are owned by the Water Corporation (see figures C2 and C5). There has been no evidence of problems with tampering or vandalism.

Bore 1/96 (Western wellfield, see Figure C1) is located on Crown Reserve 28299, under management order of the Water Corporation, and bore 6/81 (Bull Road wellfield, see Figure C5) is located on Bolgart Estate Lot 33, owned by the Water Corporation.

3.1.2 Cropping

Regionally, groundwater levels have been rising due to clearing of native vegetation for agriculture. This has resulted in an increase in groundwater salinity from salt stored in the soils. The Bull Road wellfield produces water that is more saline than the Western wellfield, hence the source waters are blended to meet quality requirements (see section 1.1).

The cropping in and around the Bolgart Water Reserve is broadacre, and occurs right up to both bore compounds (see figures C4 and C8). Risks to drinking water quality from broadacre cropping include pesticides, nutrients from fertilisers and hydrocarbons from machinery and vehicles. Cropping has been assigned a high management priority. Risks can be addressed by landowners undertaking best management practices.

3.1.3 Grazing

Grazing has not been observed adjacent to the bore compounds, however, grazing does occur in the area, and could potentially occur right up the bore compounds. The main risks to drinking water quality from grazing include pathogens and nutrients from animal faeces. Grazing has been assigned a high management priority.

3.1.4 Residences

There are several farm houses and associated sheds located within the Bolgart Water Reserve. In the Western wellfield, the closest house and sheds are 100 m away from the bore compound (see Figure C4). In the Bull Road wellfield, the nearest house and sheds are 600 m away from the bore compound (see Figure C8).

The main risks to drinking water quality from farm houses and sheds include pathogens and nutrients from septic tanks; hydrocarbons from fuel storage, leaks and spills, and farm machinery and vehicles; nutrients from garden fertilisers; and toxic chemicals from storage of farm and household chemicals. Residences have been assigned a medium management priority.

3.1.5 Rural-residential zone

Since the last plan, Lot 21 Bindi Bindi-Toodyay Road, within the western part of the Bolgart Water Reserve, has been rezoned from rural to rural-residential, via an amendment to the Shire of Victoria Plains' *Local planning scheme no. 4*, gazetted 19 March 2013.

Following this, an application to subdivide Lot 21 into 11 lots of 2 ha each was submitted to the Western Australian Planning Commission. The Shire of Victoria Plains supported the subdivision as it was in accordance with the existing planning scheme. The Department of Water did not support this due to the increased risk it would pose to the drinking water source. However, the subdivision was conditionally approved by the Western Australian Planning Commission in 2013. The area has not yet been developed, and is currently used as farming land.

The risks to water quality and public health are greater from a rural-residential area than a rural area, due to more houses, more people, more vehicles and more animals, hence this has been assigned a high management priority.

Once subdivision works begin, best management practices should be employed for construction works (section 4.2, recommendation 9). New landowners should be made aware they are living within a priority 2 area of a PDWSA (section 4.2, recommendation 10).

3.1.6 Landfill

The Bolgart landfill, operated by the Shire of Victoria Plains, is about 630 m north of the Bull Road bore compound, and is partially inside the proposed new water reserve boundary. The landfill is not lined and there is currently no groundwater monitoring in place. See figures C10 and C11.

Risks to drinking water quality from landfill sites include pathogens, nutrients, chemicals and heavy metals from leaching of contaminants into the groundwater. As a result, the landfill has been assigned a high management priority.

The Department of Water recommends that the Shire of Victoria Plains should implement a groundwater monitoring system to monitor any potential contaminant plumes that may be moving towards the drinking water bore, and investigate the proper closure of the old sections of landfill and the capture of contaminated water at the site (section 4.2, recommendation 8). This requirement should be reflected in the next update of the Department of Environment Regulation's licence for the Bolgart landfill.

Water Corporation should also consider incorporating water quality monitoring for possible contaminants from the landfill for the Bull Road wellfield (section 4.2, recommendation 6).

3.1.7 Roads

There are several farm access roads and minor public roads traversing the Bolgart Water Reserve. The closest public road to the bores is Bull Road, in the Bull Road wellfield. It runs adjacent to the bore compound (see Figure C9).

The main risk to drinking water quality from roads is hydrocarbons from vehicle accidents. There are low volumes of traffic along Bull Road and the other roads throughout the water reserve, therefore it is unlikely that a spill would occur. Roads have been assigned a medium management priority.

3.1.8 Golf course

There is a golf course located directly across the road from the Bull Road bore (Figure C6). The associated clubrooms are located just inside the new water reserve boundary, about half a kilometre away from the Bull Road bore (Figure C12).

The golf course itself is non-irrigated and non-fertilised, as it is covered by native vegetation and sand is used for the putting 'greens'. However there is some irrigation of gardens around the clubrooms via a bore located across the road from the Bull Road bore. The clubroom bore does not require a licence as it is outside the licensing area. However all bores should be adequately constructed to avoid contamination to the groundwater source (see 3.1.12 for more information).

The golf course does not appear to have a high level of usage. Irrigated golf courses are considered incompatible in P2 areas. However, this golf course is non-irrigated, and it is a pre-existing land use, so it is allowed to continue. Clubrooms are considered 'compatible with conditions' in P2 areas.

The risks to drinking water quality from the golf course and associated clubrooms include pathogens and nutrients from septic tanks and garden fertilisers, and hydrocarbons from visitors' vehicles and maintenance machinery. The golf course and clubrooms have been assigned a medium management priority.

3.1.9 Mining tenement

There is one mining tenement that covers the majority of the Western wellfield and a small portion of the Bull Road wellfield. Mining tenement E70/4670 is a pending exploration licence awaiting grant. Should the explorer wish to translate this into future mining, other forms of *Mining Act 1978* tenements need to be applied for.

3.1.10 Crown land

There are several small parcels of Crown land within the Bolgart Water Reserve reserved for various purposes in the following table.

Table 2 Crown land in the Bolgart Water Reserve

Reserve address	Vesting	Purpose
Lot 34/Crown Reserve 42324	Shire of Victoria Plains	Recreation
Lot 153 Bolgart West Road	Department of Planning	Parklands
Lot 179 Bolgart West Road	Department of Planning	Parklands
Lot 173 Bolgart West Road	Shire of Victoria Plains	Parklands
Lot 28364 Bolgart East Road	Shire of Victoria Plains	Public recreation bowling green
Lot 22 Bolgart East Road	Department of Planning	Gravel
Lot 23 Bull Road	Department of Planning	Gravel

These reserves will continue to be assigned as P2 as their current purposes align with the objective of a P2 area – risk minimisation.

3.1.11 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 Bolgart Water Reserve, covering approximately the southern half of both the Western and Bull Road wellfields. This is called Wattening-Bolgart (S01351) and is registered on the Department of Aboriginal Affairs' Aboriginal sites register system, classified as 'insufficient information'.

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 are two native title claims within the Bolgart Water Reserve, covering both the Western and Bull Road wellfields. These are the 'Yued' claim (WAD6192/98), accepted for registration, and the 'Single Noongar claim (area 1)' (WAD6006/03) not accepted for registration.

At the time of writing this plan, the State Government of Western Australia and the Noongar native title claimants are negotiating an agreement called an Indigenous Land Use Agreement (ILUA). This agreement will recognise the Noongar people as the traditional owners of land in the South West Settlement Area, which extends from

a point south of Dongara on the west coast, approximately east to a point north of Moora and then south-easterly to a point midway between Albany and Esperance (see Figure A6). This includes the Bolgart Water Reserve.

If agreed, the ILUA will enable some types of land-based customary activities to be undertaken by Noongar people in PDWSAs within the South West Settlement Area. Some of the proposed land-based activities include:

- entry to registered Aboriginal sites in reservoir protection zones
- designated camping sites for Noongar people (outside reservoir protection zones and WHPZs)
- gathering invertebrates and eggs, lighting fires and gathering flora for customary purposes.

The ILUA is available via the Department of Premier and Cabinet, see www.dpc.wa.gov.au/lantu/Claims/Pages/SouthWestSettlement.aspx.

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.

3.1.12 Other groundwater bores

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. All bores should be constructed in accordance with *Minimum construction requirements for water bores in Australia* (National Uniform Drillers Licensing Committee 2012).

3.2 Water quality information

The Water Corporation has provided updated water quality information for the Bolgart Water Reserve. This is shown in Appendix B.

Nitrate levels are elevated in both bores, but more so in bore 1/96 (Western wellfield), where it occasionally exceeds the *Australian drinking water guidelines* health level. This is thought to be due to a natural occurrence or from agricultural practices, or possibly a combination of both.

Salinity has been fluctuating at bore 6/81 (Bull Road wellfield), on occasion reaching as high as 1200 mg/L TDS (Water Corporation 2014). Water is blended from both bores to ensure that salinity is within the appropriate *Australian drinking water guidelines* range to supply to consumers.

It should be noted that barriers such as treatment and disinfection occur before water is supplied to consumers to ensure it meets appropriate standards (see Appendix B).

Table 3 Summary of potential water quality risks, land use compatibility and best management practices

Land use/activity	Hazard	Management priority	Comments	Best management practice guidance ¹
Broadacre cropping	Pesticides, nutrients from fertilisers, and hydrocarbons from machinery	High	Compatible with conditions in P2 area	PSC 88: <i>Use of herbicides in water catchment areas</i> Statewide policy no. 2: <i>Pesticide use in PDWSAs</i> WQPN 1: <i>Agriculture: dryland crops</i> WQPN 104: <i>Aerial spraying of crops with pesticides</i>
Rural-residential subdivision	Pathogens from septic tanks, nutrients from fertilisers, hydrocarbons from vehicles and chemicals from households	High	Rezoning incompatible in a P2 area; existing, approved land use	Brochure: <i>Living and working in PDWSAs</i> WQPN 65: <i>Toxic and hazardous substances</i> Brochure: <i>Construction depots in PDWSAs</i>
Landfill	Pathogens, nutrients, chemicals and heavy metals from leaching	High	Incompatible; existing, approved land use	WQPN no. 111: <i>Landfills for disposal of putrescible materials</i>
Grazing	Pathogens and nutrients from animal faeces	High	Compatible with conditions in P2 area	WQPN 35: <i>Pastoral activities in rangelands</i>
Farm houses and sheds	Pathogens from septic tanks, nutrients from fertilisers, and chemicals	Medium	Acceptable in P2 area	Brochure: <i>Living and working in PDWSAs</i> WQPN 65: <i>Toxic and hazardous substances</i>

Land use/ activity	Hazard	Management priority	Comments	Best management practice guidance ¹
Roads and tracks	Hydrocarbons from accidents	Medium	Compatible with conditions in P2 area	WQPN no. 44: <i>Roads near sensitive water resources</i>
Golf course	Pathogens from septic tanks, nutrients from fertilisers, chemicals, hydrocarbons	Medium	Golf course appears non-irrigated and non-fertilised	WQPN no. 65: <i>Toxic and hazardous substances</i>

¹ Water quality protection notes (WQPNs) are available w www.water.wa.gov.au, or see *Further reading*.

4 Recommendations

4.1 Status of previous recommendations

Table 4 outlines recommendations from the 1999 plan and their current status.

Table 4 Implementation status for Bolgart Water Reserve

No.	Recommendation	Comments
1	The three Bolgart Water Reserves should be gazetted under the <i>Country Areas Water Supply Act 1947</i> .	The boundaries of the Bull Road and Western wellfield reserves were proclaimed in 2004. The third wellfield was no longer required so it was never proclaimed. This plan recommends that the boundary be amended (section 4.2, recommendation no. 1).
2	Planning strategies should incorporate the management principles outlined in WQPN no. 25: <i>Land use compatibility in PDWSAs</i> and reflect the P2 classification.	The Shire of Victoria Plains' <i>Local planning scheme no. 5</i> and the Shire of Toodyay's <i>Local planning scheme no. 4</i> do not incorporate the Bolgart Water Reserve. This recommendation will be carried forward (section 4.2, recommendation no. 2).
3	All development proposals in the water reserves that are likely to impact on water quality should be referred to the Water and Rivers Commission.	Development proposals within all PDWSAs are referred to the Department of Water Swan Avon Region. This has been continued as a recommendation of this plan (section 4.2, recommendation no. 3).
4	Signs should be erected to define the boundaries of the water reserves and promote public awareness of the need to protect water quality.	New signs were erected in 2013 by the Water Corporation on compounds and relevant entry roads. Maintenance of these signs is a recommendation of this plan (section 4.2, recommendation no. 5).
5	A process should be put in place to address spillage of pollutants within the water reserves.	Emergency response protocols fall under Westplan-HAZMAT and the LEMC. This has been continued as a recommendation of this plan (section 4.2, recommendation no. 4).

No.	Recommendation	Comments
6	A surveillance program should be established to identify incompatible land uses or potential contamination threats within the water reserve. Also cooperation with local landowners should be sought to ensure fertiliser application rates are not excessive.	Water Corporation undertakes regular surveillance, maintenance and by-law enforcement under delegation from the Department of Water. This is continued as a recommendation of this plan (section 4.2, recommendation no. 6). This plan recommends that landowners continue to adopt best management practices including appropriate fertiliser application (section 4.2, recommendation no. 7).
7	Nutrient and pesticide levels should be monitored to ensure drinking water quality is not compromised.	Water Corporation undertakes regular water quality monitoring to ensure the water meets the drinking water quality requirements of the ADWG. This is continued as a recommendation of this plan (section 4.2, recommendation no. 6).
8	Implementation of these recommendations should be reviewed one year after this plan is endorsed. A full review of this protection plan should be undertaken approximately every five years.	This document provides the first review of the 1999 plan. Further reviews should be undertaken every seven years or as the need arises (section 4.2, recommendation no 11).

4.2 Consolidated recommendations

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

1. Amend the boundary of the Bolgart Water Reserve under the *Country Areas Water Supply Act 1947* as per Figure A5. (Department of Water)
2. Incorporate the findings of this plan and the location of the Bolgart Water Reserve (including its priority area and protection zones) in the Shire of Victoria Plains and Shire of Toodyay's local planning schemes in accordance with the Western Australian Planning Commission's State planning policy no. 2.7: *Public drinking water source policy*. (Shire of Victoria Plains, Shire of Toodyay)
3. Refer all planning proposals within the Bolgart Water Reserve that are inconsistent with the Department of Water's Water quality protection note

no.25: *Land use compatibility in public drinking water source areas* or recommendations in this plan to the Department of Water Swan Avon regional office for advice. (Department of Planning, Shire of Victoria Plains, proponents of proposals)

4. Ensure incidents covered by Westplan–HAZMAT in the Bolgart Water Reserve are addressed by ensuring that:
 - the Shire of Victoria Plains and Shire of Toodyay local emergency management committees (LEMCs) are aware of the location and purpose of the Bolgart Water Reserve
 - the locality plan for the Bolgart Water Reserve is provided to the Department of Fire and Emergency Services headquarters for the HAZMAT emergency advisory team
 - the Water Corporation acts in an advisory role during incidents in the Bolgart Water Reserve
 - personnel dealing with Westplan–HAZMAT incidents in the area have ready access to a locality map of the Bolgart Water Reserve and information to help them recognise the potential impacts of spills on drinking water quality.(Water Corporation)
5. Maintain signs on the bore compounds and access road entry points to the Bolgart Water Reserve including an emergency contact telephone number, in accordance with the Water Corporation's *S111 Source protection signage* (2013). (Water Corporation)
6. Water Corporation should continue the current regime of water quality monitoring, maintenance of fencing, inspections and by-law enforcement, and consider including water quality monitoring for possible contamination from the landfill. (Water Corporation)
7. Landowners and operators should incorporate best management practices in their farming practices (i.e. correct fertiliser and pesticide application) to assist in protecting Bolgart's drinking water quality. (landowners)
8. The Shire of Victoria Plains should implement a groundwater monitoring system, and investigate the proper closure of the old sections of landfill and the capture of contaminated water at the site. This should be reflected in the Department of Environment Regulation's licence conditions. (Shire of Victoria Plains, Department of Environment Regulation)
9. Construction works on the rural-residential subdivision on Lot 21 should adhere to best management practices to protect water quality. (landowner/contractors)
10. New landowners in the rural-residential area need to be made aware they are living within a Priority 2 area of the Bolgart Water Reserve. (Department of Water, land seller)
11. Update this plan within seven years. (Department of Water)

Appendices

Appendix A – Figures

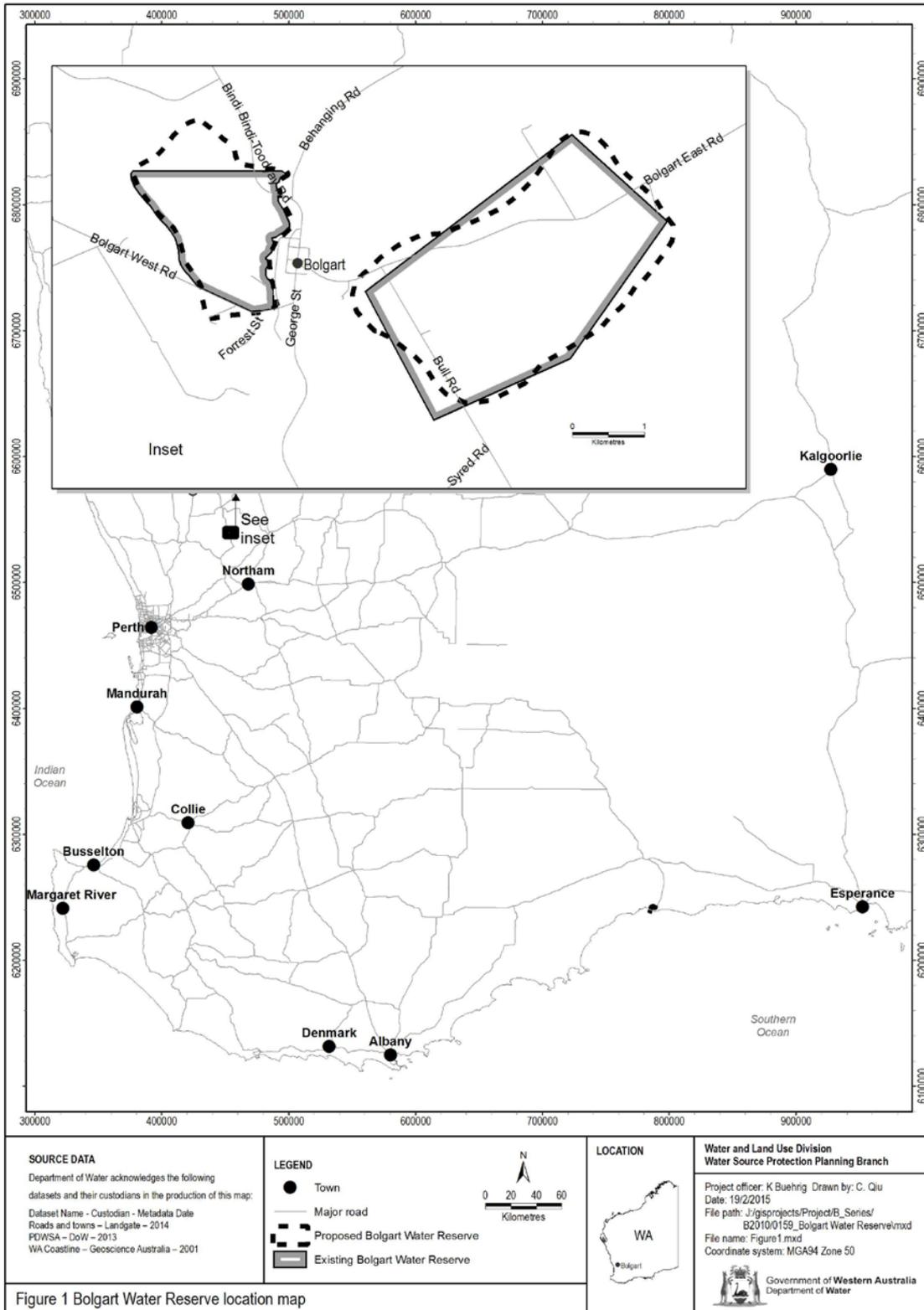


Figure A1 Bolgart Water Reserve locality map



Figure A2 Bolgart Water Reserve existing and proposed boundaries

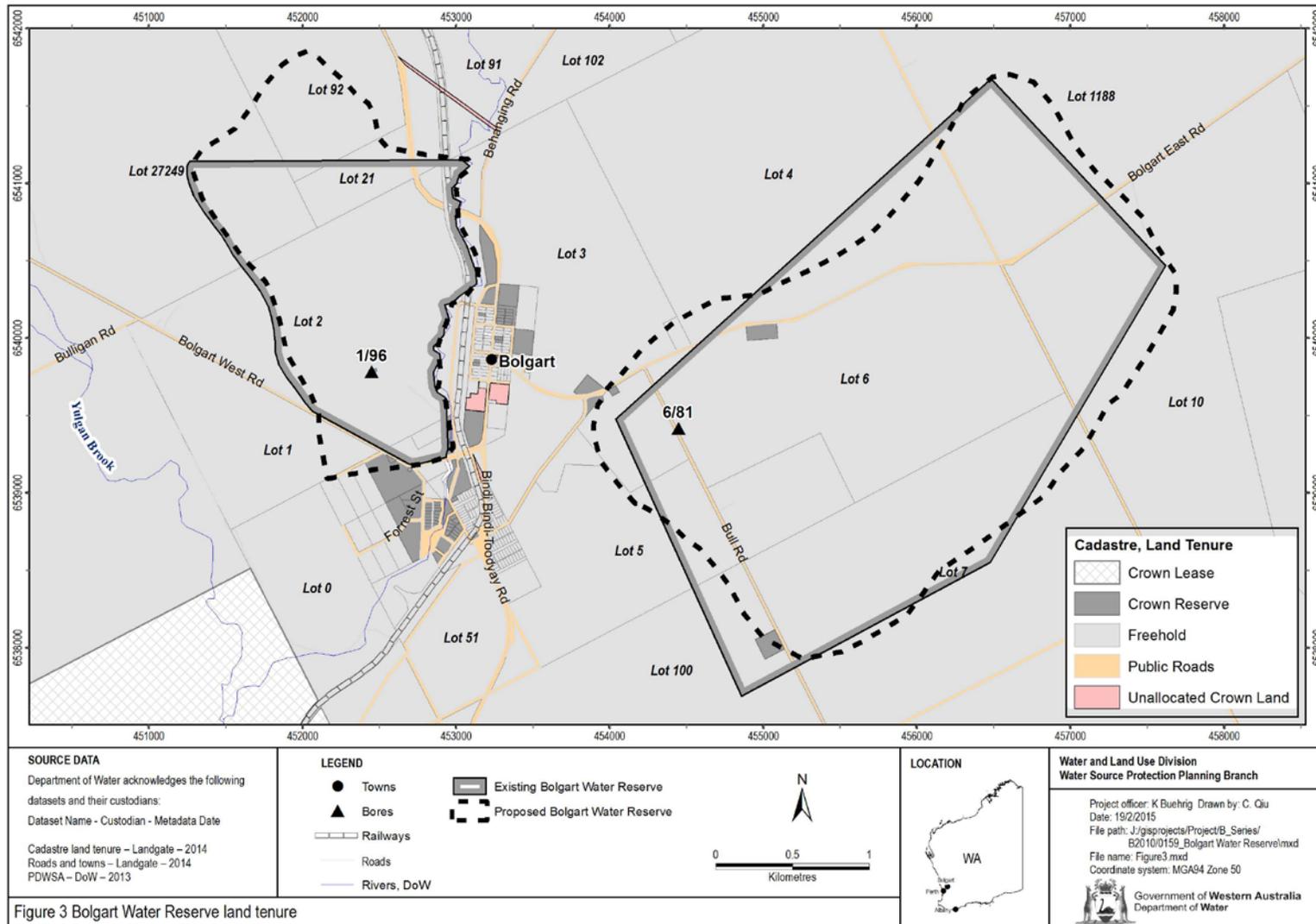


Figure A3 Bolgart Water Reserve land tenure

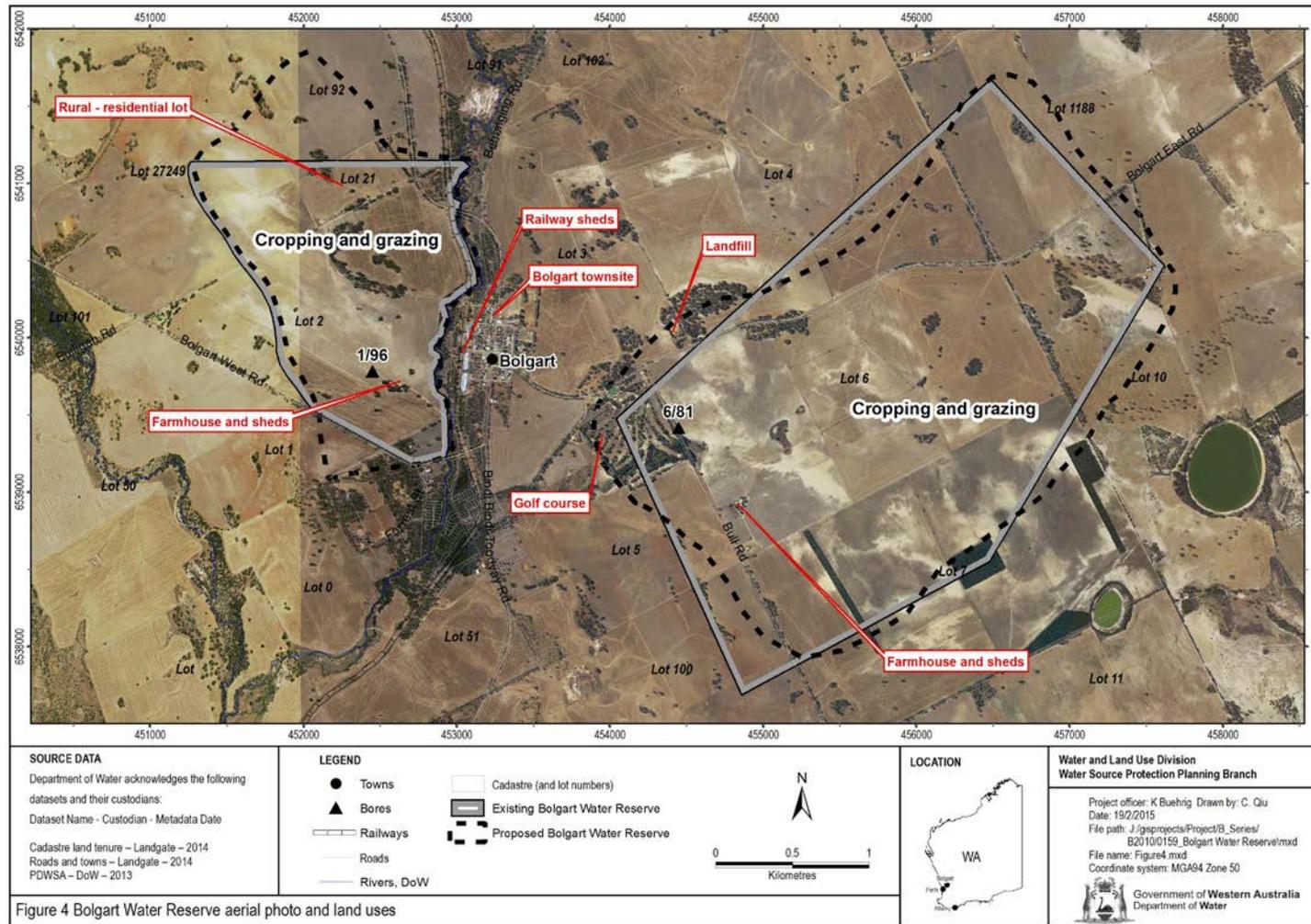


Figure A4 Bolgart Water Reserve aerial photo and land uses

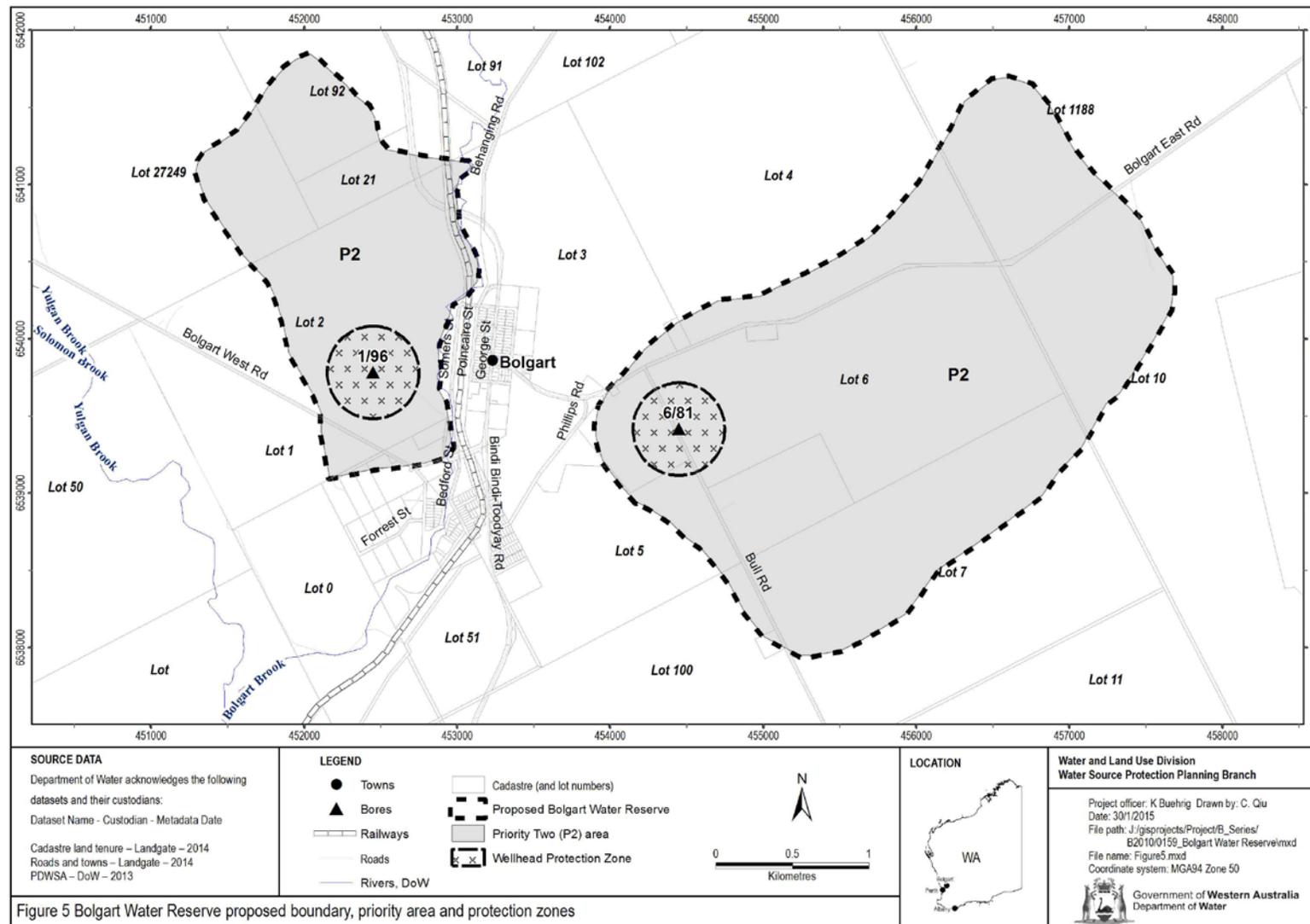


Figure A5 Bolgart Water Reserve proposed boundary, priority areas and protection zones

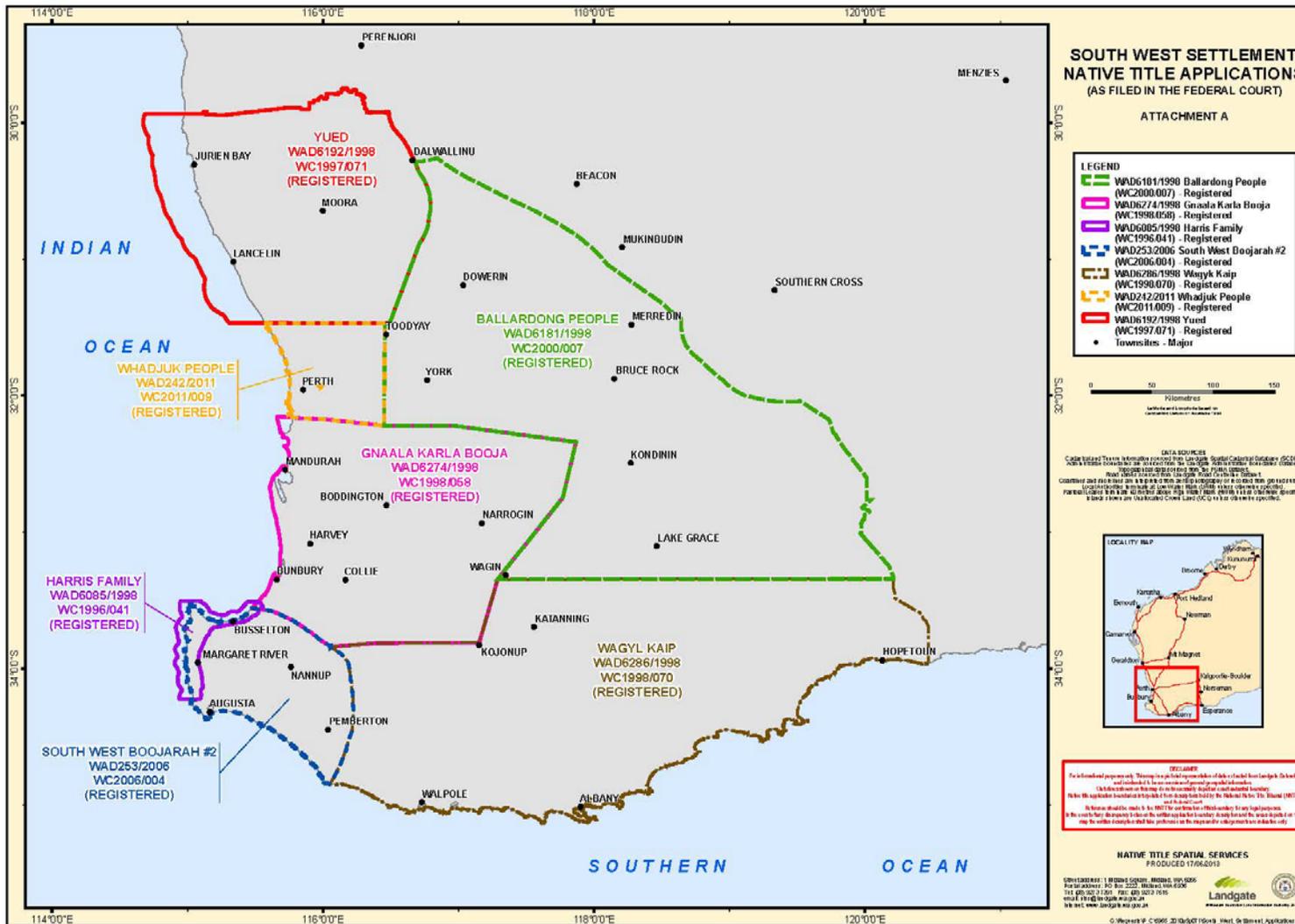


Figure A6 South West Native Title Agreement area (source: Department of Premier and Cabinet)

Appendix B – Water quality data

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

The Water Corporation has monitored the raw (source) water quality from the Western and Bull Road wellfields in accordance with the requirements of the 2004 *Australian drinking water guidelines* (ADWG; NHMRC & NRMCC 2004 and interpretations agreed to with the Department of Health. This data shows the quality of water in the Bolgart Water Reserve. The raw water is monitored regularly 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 Western and Bull Road wellfields. 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 March 2009 to March 2014.

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 Bolgart and the Mid West Region refer to the most recent Water Corporation drinking water quality annual report at <watercorporation.com.au> What we do > Water quality > Water quality publications > Most recent *Water quality annual report*.

Aesthetic characteristics

The aesthetic quality analyses for raw water from the Western and Bull Road wellfields are summarised in the following table.

Aesthetic detections for Bolgart

Parameter	Units	ADWG aesthetic guideline value*	Western wellfield (bore 1/96)		Bull Road wellfield (bore 6/81)	
			Range	Median	Range	Median
Chloride	mg/L	250	100–160	120	365–630	425
Hardness as CaCO ₃	mg/L	200	50–78	55	160– 300	190
Iron unfiltered	mg/L	0.3	<0.003–0.015	<0.003	<0.003–0.015	0.006
Manganese unfiltered	mg/L	0.1	<0.002–0.002	<0.002	Not detected	Not detected
Silicon as SiO ₂	mg/L	80	34–38	36	42–47	45
Sodium	mg/L	180	66–105	76	200–330	230
Sulfate	mg/L	250	16–28	20	31–47	35
Total filterable solids by summation	mg/L	600	299–417	325	775–1216	866
Turbidity	NTU	5	<0.1–0.8	<0.1	<0.1–2.8	0.95

Parameter	Units	ADWG aesthetic guideline value*	Western wellfield (bore 1/96)		Bull Road wellfield (bore 6/81)	
			Range	Median	Range	Median
pH (lab)	pH units	6.5–8.5	5.91 –6.88	6.28	6.32 –7.3	6.46
Copper	mg/L	1	0.02–0.025	0.0225	0.006–0.007	0.0065
Zinc	mg/L	3	<0.02–0.06	<0.04	<0.02–0.02	<0.02

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

Health-related chemicals

Raw water from Bolgart Water Reserve 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 Bolgart

Parameter	Units	ADWG health guideline value*	Western wellfield (bore 1/96)		Bull Road wellfield (bore 6/81)	
			Range	Median	Range	Median
Manganese unfiltered	mg/L	0.5	<0.002–0.002	<0.002	Not detected	Not detected
Nitrite plus nitrate as N	mg/L	11.29	8.6– 12.1	10.5	0.85–3.2	2.3

Parameter	Units	ADWG health guideline value*	Western wellfield (bore 1/96)		Bull Road wellfield (bore 6/81)	
			Range	Median	Range	Median
Sulfate	mg/L	500	16 - 28	20	31 - 47	35
Barium	mg/L	0.7	0.018–0.02	0.019	0.012–0.018	0.015
Boron	mg/L	4	0.06–0.07	0.065	0.08–0.12	0.1
Copper	mg/L	2	0.02–0.025	0.0225	0.006–0.007	0.0065
Fluoride (lab)	mg/L	1.5	<0.1–0.15	<0.1	0.15–0.35	0.2
Nitrate as nitrogen	mg/L	11.29	9.4–10.6	10.4	0.85–2.9	1.6
Nitrite as nitrogen	mg/L	0.91	Not detected	Not detected	<0.002–0.014	<0.002
Radon-222	Bq/L	100	18.8 [#]	18.8	8.97 [#]	8.97

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

† A 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.

Based on one sample taken at this source.

Microbiological contaminants

Microbiological testing of raw-water samples from the Western and Bull Road wellfields 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 the aquifer (depending on aquifer type).

During the reviewed period, positive *E. coli* counts were recorded in 5.9 per cent of samples. Detections of *E. coli* only occurred in bore 6/81 (Bull Road wellfield). This bore was resealed in 2010 and there have been no *E. coli* detections since.

Appendix C – Photographs

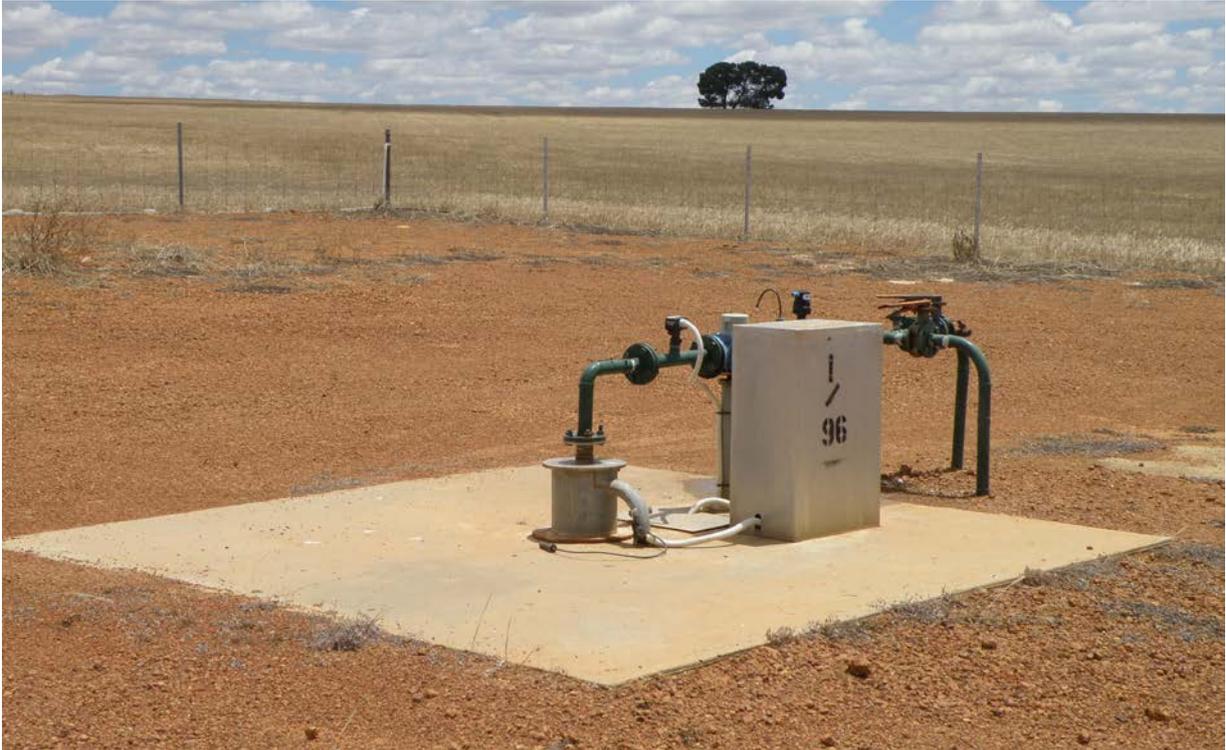


Figure C1 Bore 1/96, Western wellfield, photograph by A. Kern, Department of Water



Figure C2 Bore 1/96 compound, Western wellfield, photograph by A. Kern, Department of Water



Figure C3 Signs on Bore 1/96 compound, Western wellfield, photograph by K. Buehrig, Department of Water



Figure C4 Surrounding cropping, farmhouse and sheds near Bore 1/96 compound, Western wellfield, photograph by K. Buehrig, Department of Water



Figure C5 Bore 6/81 and surrounding compound, Bull Road wellfield, photograph by K. Buehrig, Department of Water



Figure C6 Signs on Bore 6/81 compound, Bull Road wellfield, photograph by K. Buehrig, Department of Water



Figure C7 Golf course adjacent to Bore 6/81, Bull Road wellfield, photograph by K. Buehrig, Department of Water



Figure C8 Surrounding cropping, farmhouse and sheds near Bore 6/81 compound, Bull Road wellfield, photograph by K. Buehrig, Department of Water



Figure C9 Bull Road, runs adjacent to Bore 6/81, Bull Road wellfield, photograph by A. Kern, Department of Water



Figure C10 Entry to the Bolgart landfill, photograph by M. Sawyer, Water Corporation



Figure C11 Scrap metal area at the Bolgart landfill, photograph by M. Sawyer, Water Corporation



Figure C12 Clubrooms at the golf course/bowling facility, photograph by K. Buehrig, Department of Water

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 micro-organisms (NHMRC & NRMCC 2011). Contaminants can also interfere with water treatment processes, and damage water supply infrastructure (such as iron corroding pipes).

The *Australian drinking water guidelines* (ADWG; NHMRC & NRMCC 2011) outline 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 micro-organisms that are capable of causing illness and include bacteria, protozoa and viruses. When people consume drinking water that is contaminated with pathogens, the consequences vary considerably, ranging from mild illness (such as stomach upset or diarrhoea) to hospitalisation and in some cases even death. For example, seven people died and about 2500 became ill in Walkerton, Canada, during 2000, because the town's water supply was contaminated by a pathogenic strain of *E. coli* and *Campylobacter* (NHMRC & NRMCC 2011).

The types of pathogens that are likely to cause harm to people are commonly found in the faeces of humans and domestic animals (such as dogs and cattle). These pathogens can enter drinking water supplies from faecal contamination in the catchment area, either directly or indirectly.

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 inactivation rate) and the groundwater properties (including flow rate, porosity, 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.

Given the wide variety of pathogens, their behaviour 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. 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 and chemicals can attach onto soil particles and become more difficult to remove during disinfection and treatment processes.

Other physical properties of water can affect water supply infrastructure, or the aesthetics of the drinking water. For example, pH can contribute to the corrosion and encrustation of pipes; iron and dissolved organic matter can affect the colour and smell of water; and salinity levels can affect its taste. Although not necessarily harmful to human health, water with properties like this will be less appealing to customers.

Chemical risks

Chemicals can occur in drinking water as a result of natural leaching from mineral deposits or from different land uses (NHMRC & NRMCC 2011). A number of these chemicals (organic and inorganic) are potentially toxic to humans.

Pesticides include agricultural chemicals used to control weeds (herbicides) and pests (insecticides, rodenticides, nematicides (for worms) and miticides (for 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. Harmful chemical by-products may be formed when hydrocarbons are combined with chlorine during the water treatment process. Hydrocarbons can occur in water supplies as a result of spills and leaks from vehicles and machinery.

Drinking water sources can also be contaminated by nutrients such as nitrogen and phosphorus. Nutrients can be introduced into a catchment via the application of fertiliser, from septic systems, and from animal faecal matter that washes through soil and into the groundwater. Nitrate and nitrite are two forms of nitrogen that can be toxic to humans at high levels, with infants younger than three months being most susceptible (NHMRC & NRMCC 2011).

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

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

The *Australian drinking water guidelines* (ADWG; NHMRC & NRMCC 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, developing 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.

The Department of Water's Water quality protection note no. 25: *Land use compatibility in PDWSAs* outlines appropriate development and activities within each of the priority areas (P1, P2 and P3). A draft update of this document was released for public comment in October 2014, and an updated version is expected to be published during 2016.

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 <<http://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 the 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.	Preliminary	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 changes in land and water factors and implementation of previous recommendations. Sometimes prepared to consider specific issues in a PDWSA.	Key stakeholders	3–6 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 (SPPs), recognising the importance of PDWSAs for the protection of water quality and public health:

- SPP no. 2.2: *Gnangara groundwater protection*
- SPP no. 2.3: *Jandakot groundwater protection*
- SPP no. 2.7: *Public drinking water source policy*
- SPP no. 2.9: *Water resources*.

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).

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

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. Furthermore, no previous detection of contamination is not proof that the risk is acceptable.

Shortened forms

List of shortened forms

ADWG	<i>Australian drinking water guidelines</i>
ILUA	Indigenous land use agreement
LEMC	local emergency management committee
NHMRC	National Health and Medical Research Council
NRMCM	Natural Resource Management Ministerial Council
NTU	nephelometric turbidity units
P2	priority 2
PDWSA	public drinking water source area
PSC 88	Public sector circular number 88
SPP	State planning policy
TDS	total dissolved solids
Westplan- HAZMAT	Western Australian plan for hazardous materials
WHPZ	wellhead protection zone
WQPN	water quality protection note

Units of measurement

Bq/L	becquerel per litre
m	metres
mg/L	milligram per litre
km	kilometre

Volumes of water

One millilitre	0.001 litre	1 millilitre	(mL)
One litre	1 litre	1 litre	(L)
One thousand litres	1000 litres	1 kilolitre	(kL)
One million litres	1 000 000 litres	1 megalitre	(ML)
One thousand million litres	1 000 000 000 litres	1 gigalitre	(GL)

Glossary

Abstraction	The pumping of groundwater from an aquifer, or the removal of water from a waterway or water body.
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 & NRMCC 2011).
Allocation	The volume of water that a licensee is permitted to abstract, usually specified in kilolitres per annum (kL/a).
Aquifer	A geological formation or group of formations able to receive, store and transmit significant quantities of water.
Australian drinking water guidelines	The <i>National water quality management strategy: Australian drinking water guidelines 6</i> , 2011 (NHMRC & NRMCC 2011) (ADWG) outlines acceptable criteria for the quality of drinking water in Australia (see <i>References</i>).
Becquerel	A measure of radioactivity, as per the International System of Units.
Bore	A narrow, lined hole drilled into the ground to monitor or draw groundwater (also called a well).
Catchment	The area of land which intercepts rainfall and contributes the collected water to surface water (streams, rivers, wetlands) or groundwater.
Contamination	A substance present at concentrations exceeding background levels that presents – or has the potential to present – a risk of harm to human health, the environment, water resources or any environmental value.
Dissipate	To become scattered or dispersed.
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.
Electrical conductivity	This estimates the volume of TDS or the total volume of dissolved ions in a solution (water) corrected to 25°C. Measurement units include millisiemens per metre and microsiemens per centimetre.

Fractured rock aquifer	An aquifer where groundwater is present in the fractures, joints, solution cavities, bedding planes and zones of 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.
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 & NRMCC 2011).
Hydraulic gradient	The change in hydraulic head per unit of distance, which determines the rate of groundwater flow.
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 branch of geology that deals with the occurrence, distribution and effects of groundwater. It is the study of groundwater, especially relating to the distribution of aquifers, groundwater flow and groundwater quality.
Interbedded	Layers between, or alternating with, other layers of differing geological character.
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 measurement of something (such as salinity) in a solution, i.e. 0.001 grams per litre.
Microbe	A micro-organism, usually one of vegetable nature, a germ. Also known as a bacterium, especially one causing illness.
Nephelometric turbidity units	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.
Paleochannel	Deposits of unconsolidated sediments or semi-consolidated sedimentary rocks deposited in ancient, currently inactive, river and stream channel systems.

Pathogen	A disease-producing organism that can cause sickness and sometimes death through the consumption of water, including bacteria (such as <i>Escherichia coli</i>), protozoa (such as <i>Cryptosporidium</i> and <i>Giardia</i>) and viruses.
Perched aquifer	A localised aquifer which occurs above the regional watertable, supported by an impermeable based, but has an unsaturated zone below it. Essentially, it is perched on top of another aquifer.
Permeability	Also referred to as hydraulic conductivity, this is the ability of a rock or soil unit to transmit fluids. Its magnitude depends on the size of the pore spaces (see porosity) and the degree to which they are interconnected.
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.
Pollution	Water pollution occurs when waste products change the physical, chemical or biological properties of the water, adversely affecting water quality, the ecosystem and beneficial uses of the water.
Porosity	The ratio of water (or air) filled pore spaces to the total volume of the rock or soil, expressed as a percentage or fraction.
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 <i>Metropolitan Water Supply, Sewerage, and Drainage Act 1909</i> or the <i>Country Areas Water Supply Act 1947</i> .
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	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 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.
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.
Sedimentary rocks	Rocks that have been formed by the deposition of materials. Examples are limestone, sandstone and siltstone.
Sedimentary aquifer	Aquifers occurring in sedimentary rocks.
Semi-confined aquifer	A leaky aquifer, saturated and bounded above by a semi-permeable layer and below by a layer that is either impermeable or semi-permeable.
Superficial aquifer	Shallow (near to the surface) aquifers which are easily recharged and can be readily accessed by bores.
Total dissolved solids	Consists of inorganic salts and small amounts of organic matter that are dissolved in water. Clay particles, colloidal iron and manganese oxides, and silica fine enough to pass through a 0.45 micrometer filter membrane can also contribute to total dissolved solids. Total dissolved solids comprise sodium, potassium, calcium, magnesium, chloride, sulfate, bicarbonate, carbonate, silica, organic matter, fluoride, iron, manganese, nitrate (and nitrite) and phosphate (NHMRC & NRMCC 2011).
Total filterable solids by summation	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. 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	A measure of degree of colour in water.

Unconfined aquifer	An aquifer where the upper boundary is the watertable and therefore is in contact with the atmosphere through the pore spaces in the unsaturated zone. Typically (but not always) it is the shallowest aquifer at a given location.
Water quality	Collective term for the physical, aesthetic, chemical and biological properties of water.
Water reserve	An area proclaimed under the <i>Country Areas Water Supply Act 1947</i> or the <i>Metropolitan Water Supply, Sewerage, and Drainage Act 1909</i> for the purposes of protecting a drinking water supply.
Watertable	The upper saturated level of the unconfined groundwater.
Wellfield	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.
Wellhead protection zone	Usually declared around wellheads in public drinking water source areas to protect the groundwater from immediate contamination risks.
Westplan–HAZMAT	State emergency management plan for hazardous materials emergencies.

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