Government of **Western Australia**
Department of **Water and Environmental Regulation**

Capel Water Reserve

drinking water source protection plan

Capel town water supply

Water resource protection series
Report WRP 188
May 2019

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Cover photograph: Capel aerial photograph

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Summary

Capel is approximately 200 km south of Perth on the Capel River (Figure A1), providing the economic and administrative centre for the Shire of Capel (Shire of Capel 2017).

Capel has a resident population of around 2500 (ABS 2016) and has experienced residential growth and urbanisation in recent years. Activities within and around Capel include agriculture such as beef and dairy farming, light industry, service and commercial as well as mineral sand mining.

The Water Corporation supplies Capel with reliable, high quality drinking water from the Yarragadee aquifer. This is Capel's sole supply of drinking water and it is sourced locally from deep bores within the Capel town site. The Water Corporation has recently constructed two new bores (1/16 and 2/16) within the Capel bore field to replace two ageing bores constructed in the 1970s (1/71 and 1/72). The Capel bores abstract water from 130 to 180 m below ground level.

Normally, the Yarragadee aquifer is confined by a layer of rock and is considered confined at a regional level. However, at Capel, the layer of rock is absent and the aquifer is considered locally to be semi-confined. This means that contamination from surface land uses near the bore field has the potential to leach down into Capel's drinking water source.

This plan proposes to constitute a Capel Water Reserve over a 300 m radius from the Capel bore field to protect the bore area that is most vulnerable to water quality contamination risks (Figure A2).

The Department of Water and Environmental Regulation recommends the following strategies to protect water quality within the proposed Capel Water Reserve:

- proclaim the Capel Water Reserve under the *Country Areas Water Supply Act 1947*
- establish a 300 m wellhead protection zone (WHPZ) over the entire water reserve
- assign priority 1 (P1) areas to all Crown, state and Water Corporation land (figures A2 and A3)
- assign priority 3 (P3) areas to all private land (Figure A2)
- identify the Capel Water Reserve in the *Capel local planning scheme*
- connect the residential area to deep sewerage if the area is further subdivided, or use aerobic treatment units if deep sewerage is not feasible
- implement best management practices within the existing special use (industrial) area to help protect the drinking water source.

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

We have prepared this document in consultation with key stakeholders, including land owners, the Water Corporation and the Shire of Capel.

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

Table 1 Key information about the Capel Water Reserve

Local government authority	Shire of Capel
Locations supplied	Capel
Aquifer type	Locally semi-confined Yarragadee aquifer
Licensed abstraction	450 000 kL/year (licence 62154)
Number of bores	Four (two to be decommissioned)
Bore name and GPS coordinates	1/71 (E 367 145, N 6 286 332) – reaching the end of its functional life 1/72 (E 367 090, N 6 286 352) – offline and capped 1/16 (E 367 147, N 6 286 351) 2/16 (E 367 152, N 6 286 321)
Date of bore completion	1/71 – 1971 1/72 – 1972 1/16 – 2016 2/16 – 2016
Consultation	Shire of Capel, Water Corporation, South West Aboriginal Land and Sea Council, Western Australian Local Government Association, private landowners, mining tenement holder, Department of Health, Department of Planning, Lands and Heritage, Department of Mines, Industry Regulation and Safety
Drinking water source protection reports	2018 – *Capel Water Reserve drinking water source protection plan* (this document)
Proclamation status	Proclamation will be progressed under the *Country Areas Water Supply Act 1947* when this plan is finalised.
Reference documents	*Australian drinking water guidelines* (NHMRC & NRMMC 2011) State planning policy no. 2.7: *Public drinking water source policy* (Western Australian Planning Commission 2003)

	South West groundwater areas allocation plan (Department of Water and Environmental Regulation 2009) *Capel River action plan* (Geographe Catchment Council and the Capel Land Conservation District Committee1999)

1 Overview

1.1 The drinking water supply system

Capel's drinking water is sourced from a Water Corporation bore compound within the town (Figure A1). Two production bores (1/71 and 1/72) have supplied Capel's drinking water since the 1970s (Figure A3). These bores are screened in the upper Yarragadee aquifer between 160 and 180 m deep. Production bore 1/72 recently collapsed and has been permanently taken offline and sealed (Figure D1), while production bore 1/71 is still in use but nearing the end of its functional life (Figure D2).

Water Corporation recently constructed two new production bores within the same compound to replace the older bores. Production bore 2/16 (Figure D3) is equipped and able to supply drinking water when bore 1/71 fails, while production bore 1/16 (Figure D4) will be equipped in the near future. Both bores are screened from about 135 to 180 m deep.

Water drawn from the Yarragadee aquifer is chlorinated to disinfect the water, aerated and filtered to reduce naturally occurring iron, manganese and turbidity, before being pumped from a ground-level tank into the town scheme.

Following completion of the two new bores, Water Corporation will upgrade its treatment plant. The ageing diesel generator was recently replaced with a self-bunded diesel generator (Figure D5).

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 F.

1.2 Water management

1.2.1 Licence to take water

Water resource use and conservation in Western Australia is administered by the Department of Water and Environmental Regulation in accordance with the *Rights in Water and Irrigation Act 1914*. Under this act, the right to use and control water is vested with the Crown. This means that a licence is required for drilling bores and abstracting groundwater (pumping water from a bore, spring or soak) within proclaimed groundwater areas throughout the state. Some exemptions apply such as abstracting water for domestic purposes only.

The proposed Capel Water Reserve is located within the Busselton–Capel Groundwater Area (and the Busselton–Yarragadee subarea) which is proclaimed under the *Rights in Water and Irrigation Act 1914*. The Department of Water and Environmental Regulation has issued licence 62154 to the Water Corporation to abstract 450 000 kL of groundwater from the Capel bore field for public water supply.

1.2.2 Water planning and future water needs

Abstraction at Capel was over 340 000 kL for the 2016–17 reporting year, which is 76 per cent of the annual allocation. The Water Corporation predicts that water use in Capel will remain below the current allocation for at least the short- to medium-term.

The *South West groundwater areas allocation plan* (Department of Water 2009) reserved an additional 350 000 kL per year from the Yarragadee aquifer (Busselton-Capel subarea), catering for any increase in public drinking water supply in the mid- to long-term. The Yarragadee aquifer in the Busselton-Capel subarea is otherwise fully allocated with no additional water available.

1.3 Characteristics of the catchment

1.3.1 Physical environment

The Capel bore field is located in Capel on the Swan Coastal Plain. The bore compound is situated between the Capel River and an industrial area and is surrounded by residential properties.

The Capel River lies between 30 and 50 m from the compound. There is a steep gradient from the compound down into the river valley. The Capel River foreshore is vegetated, though some areas of understorey have been cleared for cattle grazing.

1.3.2 Climate

Capel has a Mediterranean-type climate with warm to hot summers and mild, wet winters. Annual rainfall has averaged about 690 mm since 2003, with the majority of rainfall occurring between May and September (Bureau of Meteorology 2018).

Temperatures range from about 5 to 26°C in winter and 14 to 40°C in summer.

1.3.3 Hydrogeology

The Yarragadee aquifer is the largest aquifer system of the South West groundwater area. It is composed of the Yarragadee Formation, basal units of the overlying Parmelia formation and parts of the underlying Cockleshell Gully and Lesueur sandstone formations. The aquifer ranges in thickness from about 300 to 1700 m within the Bunbury Trough and contains mostly fresh water.

The Yarragadee aquifer is believed to be predominantly recharged by direct rainfall infiltration in a region south of Nannup, with additional minor leakage from the overlying Leederville formation.

The Yarragadee aquifer is regionally confined from the overlying Leederville aquifer by the discontinuous aquitards formed by the Bunbury basalt and shale units of the Parmelia formation. It is unconfined where it outcrops in areas on the Blackwood Plateau and subcrops beneath the superficial aquifer on the coastal plains.

At Capel, the Yarragadee aquifer is considered locally semi-confined as the overlying layer of Bunbury basalt or shale is absent. Leakage from the overlying aquifer is likely through semi-permeable interbedded sands, siltstones and clays of the Leederville aquifer. While the semi-confining layers of clay provide some natural protection, surface contamination near the Capel bore field has the potential to infiltrate through the superficial and Leederville aquifers into the Yarragadee aquifer. (Department of Water 2009).

1.4 How is this drinking water source currently protected?

The Capel Water Reserve is not yet proclaimed under the *Country Areas Water Supply Act 1947*.

The production bores and water treatment plant are contained in a fenced, locked compound to deter unauthorised access and vandalism (Figure D6). The Water Corporation employs best management practices for operating and managing the production bores, water treatment plant and compound (Water Corporation 2011). The compound is regularly inspected by Water Corporation staff.

1.5 Other water management information

1.5.1 Other groundwater bores in the area

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

It is therefore important to ensure that any bores are appropriately located and constructed to prevent contamination of the public drinking water source. This will be assessed through the Department of Water and Environmental Regulation’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 Uniform Drillers Licensing Committee 2012).

There are two licensed users within the Capel Water Reserve; one drawing water from the Leederville aquifer and the other from the Yarragadee aquifer.

1.6 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 Capel Water Reserve; the Capel River (Figure A5).

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 Capel Water Reserve; the Gnaala Karla Booja (WAD6274/1998) (Figure A5).

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

2 Common contamination risks

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 run-off 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. 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.

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

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

2.1 Microbiological risks

Pathogens are types of microorganisms that are capable of causing illness. These include bacteria, protozoa and viruses. In drinking water supplies, pathogens that impact human health 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 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 (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 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 aquifer 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 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 the groundwater system to be able to protect a 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.

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 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.

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 & 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 (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 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.

3 Contamination risks in this drinking water source

3.1 Water quality

The Water Corporation tests raw water from the Capel bore field for microbiological, health-related and aesthetic (non-health-related) characteristics. This data shows the quality of water in the PDWSA. An assessment of the drinking water quality once treated is also made against the ADWG. This assessment is made by an interagency committee called the Advisory Committee for the Purity of Water, chaired by the Department of Health.

A water quality summary for the Capel bore field from November 2012 to October 2017 is presented in Appendix B. For more information on water quality, see the Water Corporation’s most recent drinking water quality annual report at www.watercorporation.com.au.

Raw water from the Yarragadee aquifer at Capel has exceeded the ADWG aesthetic guideline values due to the naturally occurring levels of turbidity, iron, manganese and pH. The health guideline values were not exceeded for any parameters during the review period. *Escherichia coli* was detected in 1.7 per cent of samples (a single detection) during the period (see also section 3.2.2).

Water from this wellfield is disinfected via chlorination, then aerated and filtered to ensure the quality of the reticulated water meets the ADWG aesthetic and health guideline values.

3.2 Land uses and activities

The proposed Capel Water Reserve is located over a mixture of Crown and privately owned land. Current land uses and activities and their risks to the drinking water source are described below. Appendix C displays a more detailed risk assessment, and includes recommended protection strategies to address water quality risks.

The risk of contamination from surface land uses at Capel is already considerably reduced because of the depth of abstraction and the natural protection provided by the semi-confining layers of clay. By proclaiming the Capel Water Reserve under the *Country Areas Water Supply Act 1947*, it will be recognised in state and local government planning systems and emergency response. This will provide additional water quality protection. The protection strategies detailed in Appendix C are recommended for land uses with higher inherent risks such as industrial uses, high density unsewered residential areas and mining activities.

3.2.1 Special use (industrial) area

A special use (industrial) area is adjacent to the Water Corporation bore field (Figure A4). The industrial area covers six lots owned by a single company and a portion of a residential property. A dairy processing facility with a wastewater treatment plant and a fuel depot previously operated in this area. A single dairy factory continues to operate on the western-most lot of the estate.

Most of the industrial area is currently being redeveloped. The existing buildings and facilities are being demolished and the hazardous materials are being removed. A fuel depot and underground fuel storage tank and was previously removed and the site remediated.

Water quality risks from existing land uses include pathogens and nutrients from septic tanks and nutrients, turbidity and toxic chemicals from the dairy factory and demolition works.

3.2.2 Water Corporation compound

Pathogens were detected in a sample of raw water from the Capel bore field. An investigation identified that small animals and insects entering the bores and pipes were the likely source. The older bores have since been permanently sealed and the new production bores are properly constructed to prevent this from happening again. There have been no further detections of pathogens.

The Water Corporation compound lies within the 1 in 100 year flood plain extent (1 per cent average exceedance probably (AEP). The production bores and headworks are properly constructed to prevent the ingress of potentially contaminated flood waters directly into the aquifer.

3.2.3 Residential area

The proposed Capel Water Reserve covers an existing residential area zoned urban under the *Greater Bunbury Region Scheme* (figures A3 and A4). Lots in the western area of the water reserve along Hutton Road and Scott Road are connected to deep sewerage. In the eastern area of the water reserve, lot sizes range from about 3500 to 4500 m^2 and are not connected to deep sewerage.

Residential land uses are acceptable in P3 areas. For any new residential lots smaller than two hectares, we recommend connection to deep sewerage. If the lots are exempt under the *Draft government sewerage policy* (Department of Planning 2016), then aerobic treatment units should be used (Department of Water 2016b).

Water quality risks from the residential area include pathogens and nutrients from septic tanks and pesticides and nutrients from gardens.

3.2.4 Capel River and foreshore

The Capel River runs through the middle of the Capel Water Reserve (figures A3 and A4). There is recreation along the Capel River, including walking, swimming and fishing.

Recreation on Crown land within the Capel Water Reserve is considered compatible under our Statewide Policy no.13: *Recreation within public drinking water source* *areas on Crown land* (Department of Water 2012), with the exception of off-road driving, horseriding and hunting.

The river foreshore is zoned *Regional open space* under the *Greater Bunbury Regional* scheme and *Foreshore protection* under the Shire of Capel's local planning scheme. These areas include heavily vegetated land and cleared areas of privately owned land used for cropping and stock grazing.

Risks to water quality along the Capel River and foreshore include pesticides from agriculture and foreshore management, nutrients from agriculture and livestock and pathogens from livestock and human access.

3.2.5 Roads and vehicles

Roads and vehicles within urban areas can pose risks to groundwater quality from accidents, leaks and spills. The hazards include hydrocarbons, heavy metals and turbidity.

Vehicle use on the roads, residential area and special use (industrial) area is currently low. The main risks from vehicle use are likely to be associated with any future increase in car and heavy vehicle use within the existing special use (industrial) area.

3.2.6 Contaminated sites

The Water Corporation compound has been classified as *decontaminated* under the *Contaminated Sites Act 2003*, which is administered by the Department of Water and Environmental Regulation.

3.3 Possible future contamination risks

Future land uses within the proposed Capel Water Reserve should be consistent with the recommendations in WQPN 25 *Land use compatibility tables for public drinking water source areas* (Department of Water 2016b).

3.3.1 Redevelopment of the Special use (industrial) area

The existing dairy processing facility and associated buildings in the special use (industrial) area are in the process of being demolished and the site is being cleared for future land uses.

Our WQPN no. 25: *Land use compatibility tables for public drinking water source areas* (Department of Water 2016b) outlines appropriate development and activities within each of the priority areas (P1, P2 and P3). Development proposals that are inconsistent with WQPN no. 25 or the recommendations in this plan should be referred to the Department of Water and Environmental Regulation nearest regional office for advice. We recommend that industrial, commercial, residential and other urban land uses are connected to deep sewerage to minimise risks to groundwater quality.

The department recommends that best management practices are implemented during the construction and operation of future land uses to protect groundwater quality, in particular for stormwater management and chemical storage. Please refer to our WQPN series (available www.dwer.wa.gov.au) to select the appropriate notes for guidance.

3.3.2 Mining

A single exploration mining tenement covers part of the Capel Water Reserve (Figure A6). However, mining is unlikely to occur within the water reserve due to the extent of existing urban land uses.

4 Protecting your drinking water source

This plan's objective is to protect water quality in the proposed Capel Water Reserve to ensure a safe, reliable source of good quality drinking water to consumers now and in the future.

4.1 Proclaiming public drinking water source areas

The proclamation process begins with consultation during the development of a drinking water source protection report. This plan recommends proclamation of the proposed Capel Water Reserve under the *Country Areas Water Supply Act 1947*.

Once the water reserve is proclaimed the local government authority will incorporate the public drinking water source area (PDWSA) into their planning schemes consistent with State planning policy no. 2.7: *Public drinking water source policy*. PDWSAs are commonly shown in planning schemes as special control areas. This provides guidance for state and local government planning decision makers and developers.

Proclamation of a PDWSA will not change the zoning of land. All existing, approved land uses and activities in a proclaimed area can continue. However, we recommend that best management practices are employed in PDWSAs to protect the quality of the drinking water source. New developments or expansion of existing land uses or activities need to consider the recommendations in this plan. As a general guide, the Department of Water and Environmental Regulation does not recommend land use intensification in a PDWSA because of the increased risks to drinking water quality and public health.

For more guidance on appropriate land uses and activities, please refer to our WQPN no. 25: *Land use compatibility in public drinking water source areas* (Department of Water 2016b) which outlines appropriate development and activities within each of the priority areas (P1, P2 and P3).

4.2 Defining the Capel Water Reserve boundary

We propose a circular boundary for the Capel Water Reserve, based on the extent of a 300 m wellhead protection zone (WHPZ) around the Capel bore field (Figure A2). This is considered sufficient protection because:

- this protects the area most vulnerable to surface contamination
- the Capel production bores are screened very deep (at least 130 m below ground level) in the Yarragadee aquifer
- the semi-confined nature of the aquifer significantly reduces contamination risks
- the production bores are adequately constructed to prevent the ingress of surface water or groundwater from aquifers above the Yarragadee.

This boundary has been determined in accordance with our Strategic policy: *Protecting public drinking water source areas in Western Australia* (Department of Water 2016a).

4.3 Defining priority areas

The protection of PDWSAs relies on statutory and non-statutory measures for water resource management and land-use planning. The Department of Water and Environmental Regulation's policy for the protection of PDWSAs includes a system that defines three specific priority areas:

- Priority 1 (P1) areas have the fundamental water quality objective of risk avoidance (e.g. state forest and other Crown land).
- Priority 2 (P2) areas have the fundamental water quality objective of risk minimisation (e.g. land that is zoned rural).
- Priority 3 (P3) areas have the fundamental water quality objective of risk management (e.g. areas zoned urban, industrial or commercial).

The determination of priority areas is based on the strategic importance of the land or water source including risks to water quality and quantity, the local planning-scheme zoning, the form of land tenure and existing approved land uses or activities. For further detail, please refer to our WQPN no. 25: *Land use compatibility in public drinking water source areas* (Department of Water and Environmental Regulation 2016b).

The proposed priority areas for the Capel Water Reserve have been determined in accordance with current Department of Water and Environmental Regulation policy. These areas are described below and displayed in Figure A2. Our WQPN no.25 outlines activities that are 'acceptable', 'compatible with conditions' or 'incompatible' within the different priority areas.

We propose to assign the Water Corporation land, Crown land and government–owned freehold land in the Capel Water Reserve as P1 because:

- water from this source is the only supply available to Capel
- current land uses on the Water Corporation and government–owned are considered 'acceptable' in P1.

We propose to assign the remaining private land as P3 because:

- current land uses are considered 'acceptable' or 'compatible with conditions' provided best management practices are applied
- the land is privately owned and zoned for urban residential and industrial uses.

4.4 Defining protection zones

In addition to priority areas, protection zones are defined in PDWSAs to protect water from contamination in the immediate vicinity of water extraction facilities (i.e. bores or dams). Specific conditions may apply within these zones such as restrictions on the storage of chemicals or prohibition of public access.

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

A WHPZ is proposed over the entire Capel Water Reserve (Figure A2) given its small size.

4.5 Planning for future land uses

As outlined in the WAPC's State planning policy no. 2.7: *Public drinking water source policy* (2003) it is appropriate that the Capel Water Reserve, its priority areas and protection zone be recognised in the Capel local planning scheme. Any development proposals in the Capel Water Reserve that are inconsistent with advice in our WQPN no.25: *Land use compatibility in public drinking water source areas* (Department of Water 2016b) or recommendations in this plan, need to be referred to our nearest regional office for advice.

The department's protection strategy for PDWSAs provides for approved developments to continue even if those facilities would not be supported under current water quality protection criteria. In these instances, the department can provide advice to landowners or operators on measures they can use to improve their facilities and reduce water quality contamination risks (see section *4.6: Using best management practices*).

4.6 Using best management practices

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

Guidelines on best management practices for many land uses are available in the form of industry codes of practice, environmental guidelines and WQPNs. They recommend practices to help managers reduce their impacts upon water quality. These guidelines have been developed in consultation with stakeholders such as industry groups, agricultural producers, state government agencies and technical advisers. Examples include WQPN no. 65 *Toxic and hazardous substance storage and use*, WQPN no. 70 *Wastewater treatment and disposal – domestic systems* and WQPN no. 52 *Stormwater management at industrial sites* which are listed in this plan's *Further reading* section.

Education and awareness-raising (such as through providing information on signs and publications) are key mechanisms for protecting water quality, especially for people visiting the area.

4.7 Enforcing by-laws and surveying the area

The quality of water in PDWSAs within country areas of the state is protected under the *Country Areas Water Supply Act 1947*. Proclamation of PDWSAs allows by-laws to be applied to protect water quality.

The Department of Water and Environmental Regulation considers by-law enforcement, through surveillance of land-use activities in PDWSAs, to be an important mechanism to protect water quality.

Signs will be erected on the boundaries of this water reserve to educate and advise the public about activities that are prohibited or regulated. This plan recommends that surveillance and by-law enforcement for the Capel Water Reserve be formally delegated to the Water Corporation.

4.8 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 Capel local emergency management committee (LEMC), through the South West emergency management district, should be familiar with the location and purpose of the Capel Water Reserve. A 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 Capel 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 Capel Water Reserve. These personnel should have an adequate understanding of the potential impacts of spills on this drinking water source.

4.9 Implementing this plan

Appendix C identifies potential water quality risks associated with existing land uses in the Capel Water Reserve and recommended protection strategies to deal with those risks.

Refer to Appendix F to gain a greater understanding about the risk assessment process we use.

5 Recommendations

The following recommendations apply to the entire Capel Water Reserve. The bracketed stakeholders are those expected to have a responsibility for, or an interest in, the implementation of that recommendation.

1. Proclaim the Capel Water Reserve under the *Country Areas Water Supply Act 1947*. (Department of Water and Environmental Regulation)
2. Incorporate the findings of this plan and location of the Capel Water Reserve (including its priority areas and protection zones) in the Capel 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 Capel)
3. Refer development proposals within the Capel Water Reserve that are inconsistent with the Department of Water and Environmental Regulation's WQPN no.25: *Land use compatibility in public drinking water source areas* or recommendations in this plan to the Department of Water and Environmental Regulation regional office for advice. (Department of Planning, Shire of Capel, proponents of proposals)
4. Ensure incidents covered by Westplan–HAZMAT in the Capel Water Reserve are addressed by ensuring that:
   - the Shire of Capel LEMC is aware of the location and purpose of the Capel Water Reserve
   - the locality plan for the Capel Water Reserve is provided to the Fire and Emergency Services Authority headquarters for the HAZMAT emergency advisory team
   - the Water Corporation acts in an advisory role during incidents in the Capel Water Reserve
   - personnel dealing with Westplan–HAZMAT incidents in the area have ready access to a locality map of the Capel Water Reserve and information to help them recognise the potential impacts of spills on drinking water quality. (Water Corporation)
5. Erect signs along the boundary of the Capel Water Reserve including an emergency contact telephone number. (Water Corporation)
6. Connect the residential area to deep sewerage if the area is further subdivided. If exempt under the *Draft government sewerage policy*, the use of aerobic treatment units is recommended. (proponents of proposals)
7. Implement best management practices in the redeveloped special use (industrial) area to minimise risks to groundwater quality. (landowners)
8. This report will be reviewed in seven years or in response to changes in water quality contamination risks. (Department of Water and Environmental Regulation)

Appendices

Appendix A — Figures

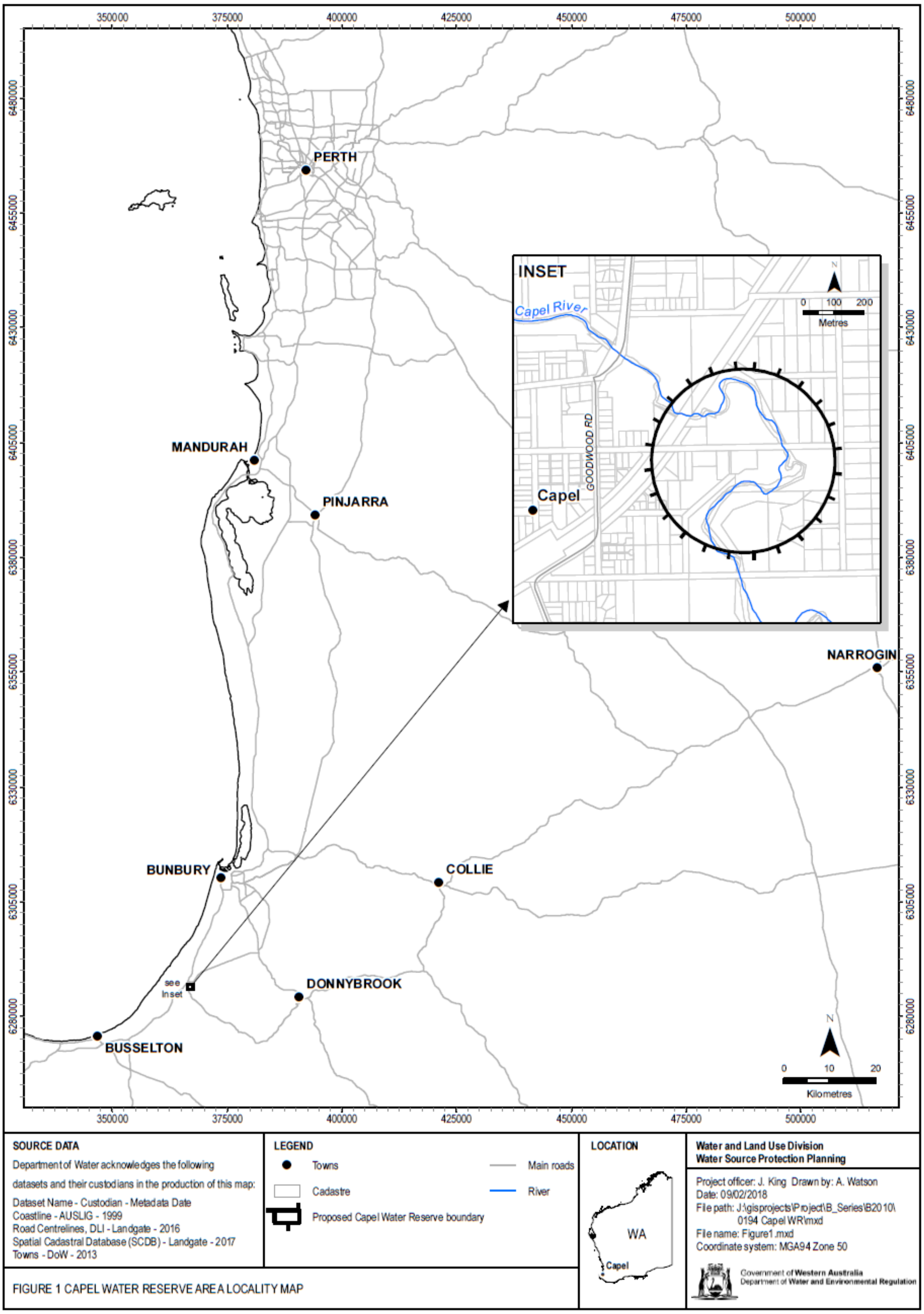

Figure A1 Proposed Capel Water Reserve locality map

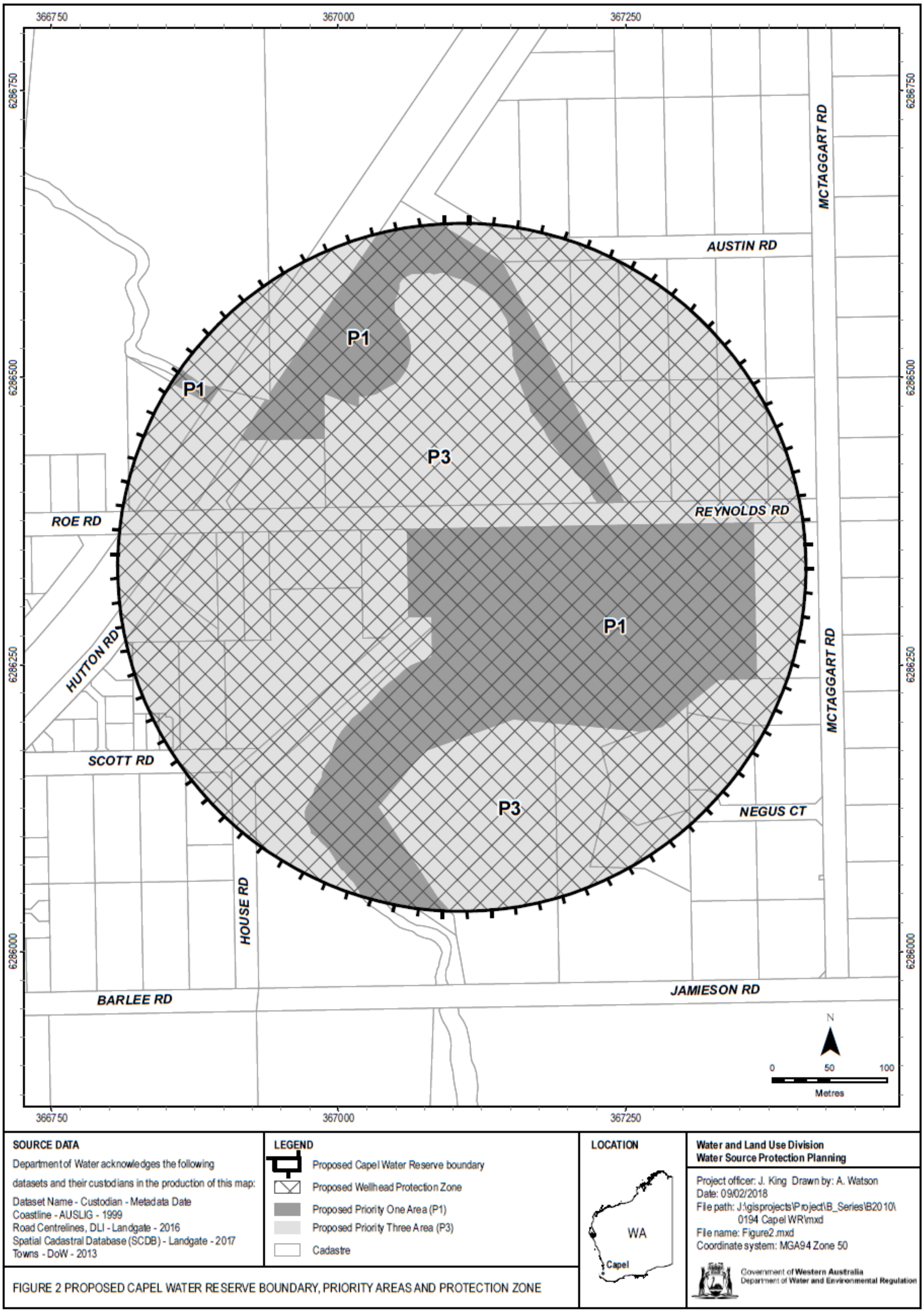

Figure A2 Recommended boundary, priority areas and protection zone for Capel Water Reserve

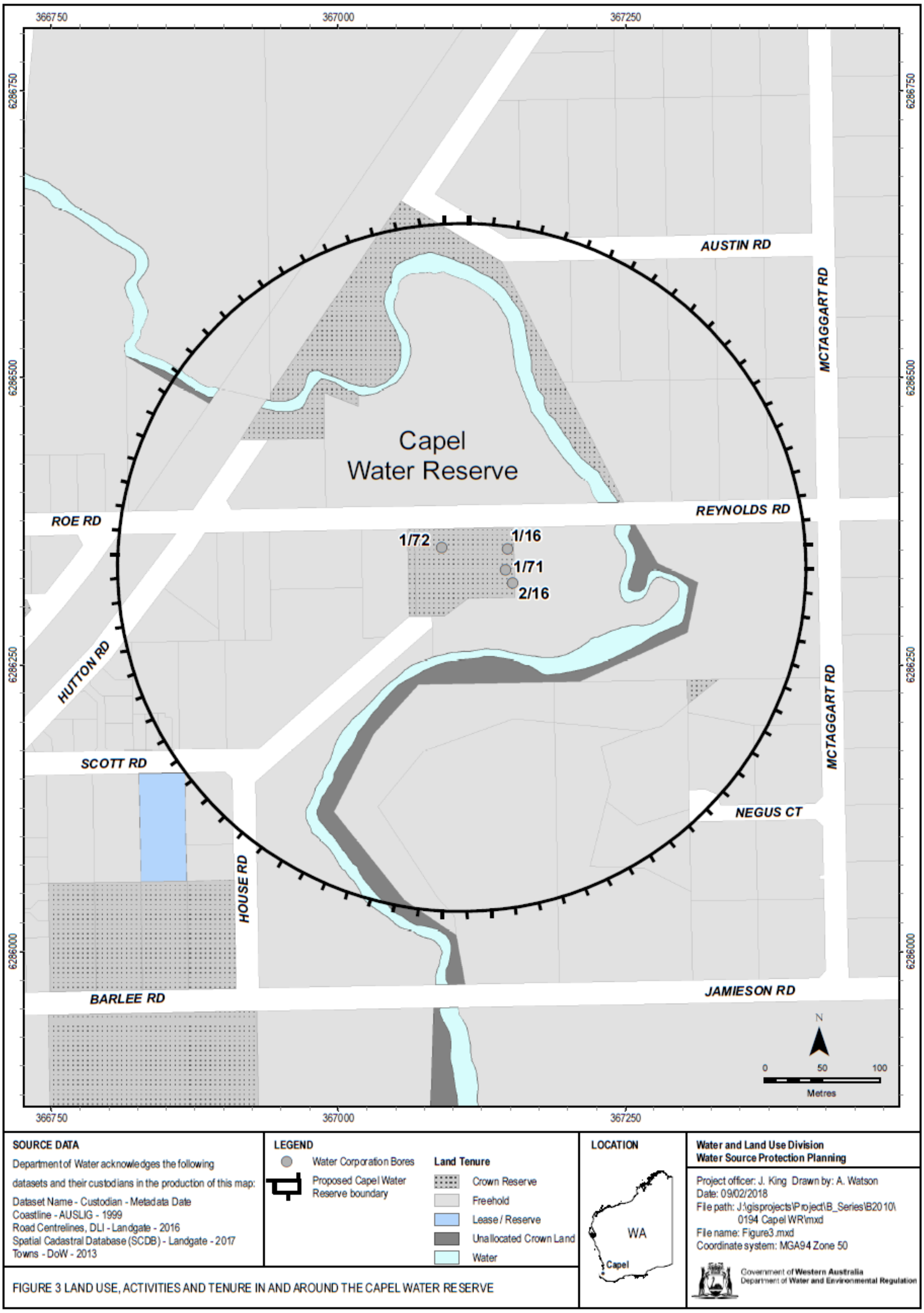

Figure A3 Land use, activities and tenure in the proposed Capel Water Reserve

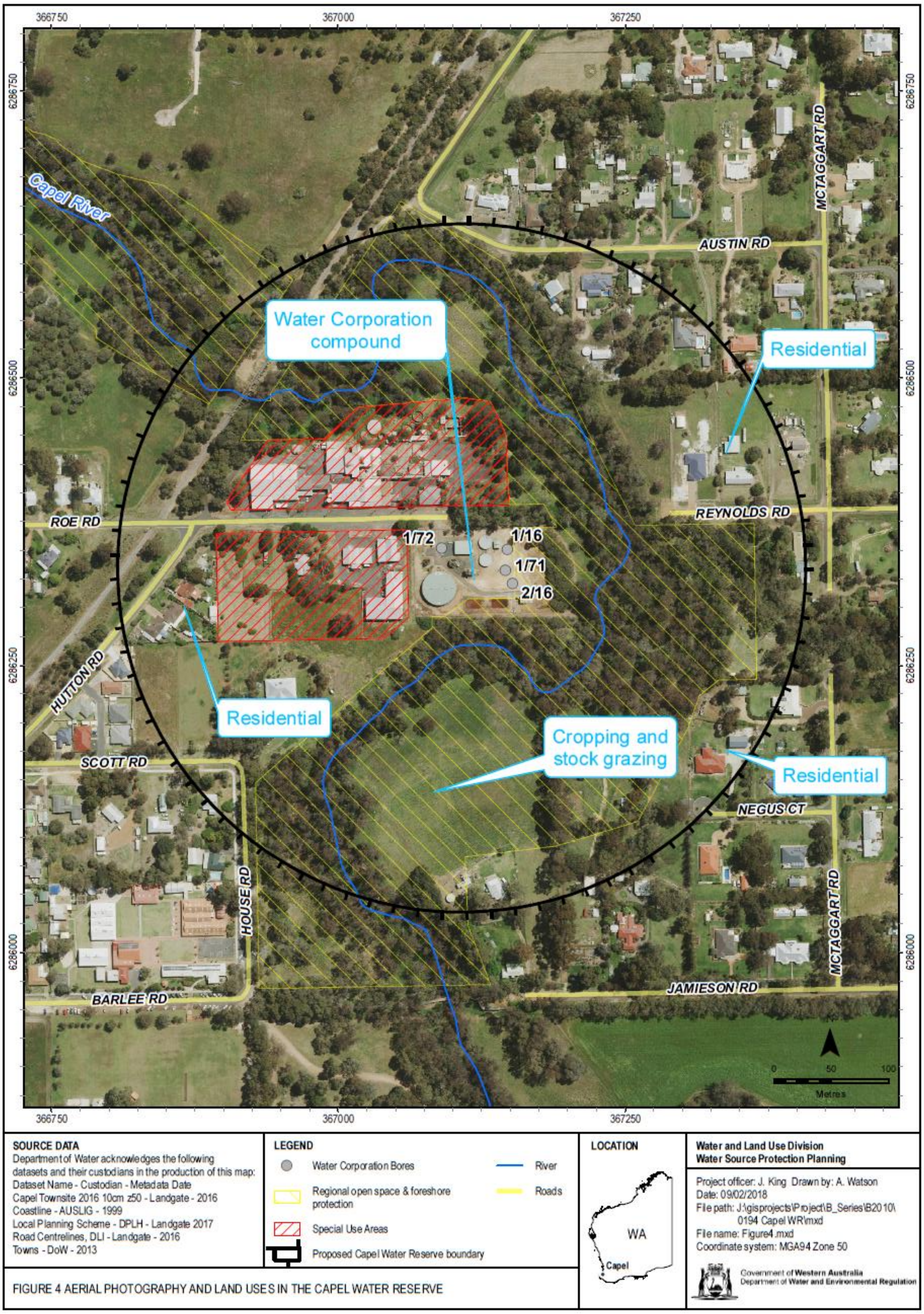

Figure A4 Proposed Capel Water Reserve – aerial and other land use information

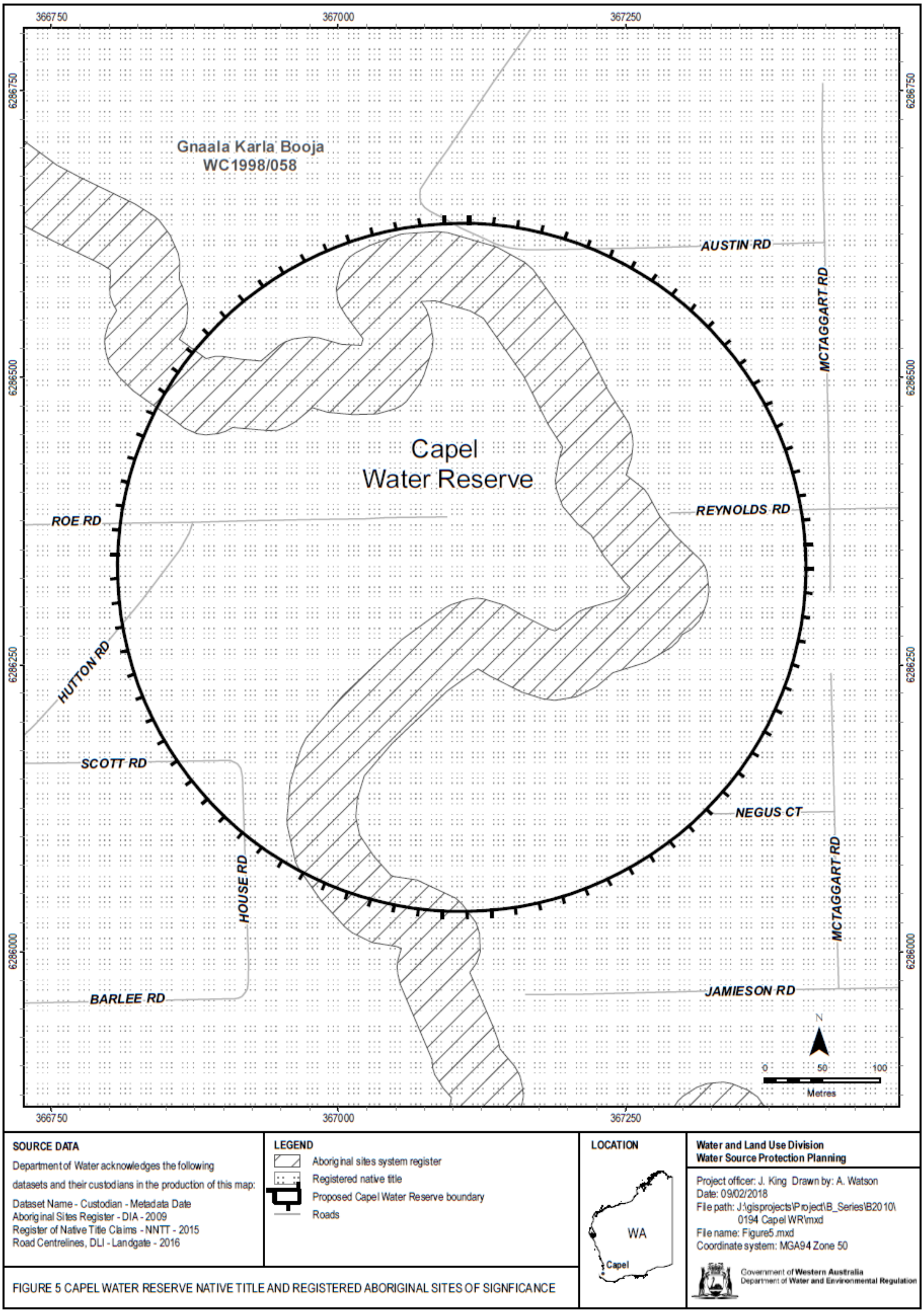

Figure A5 Proposed Capel Water Reserve – Native Title and Aboriginal Sites of Significance

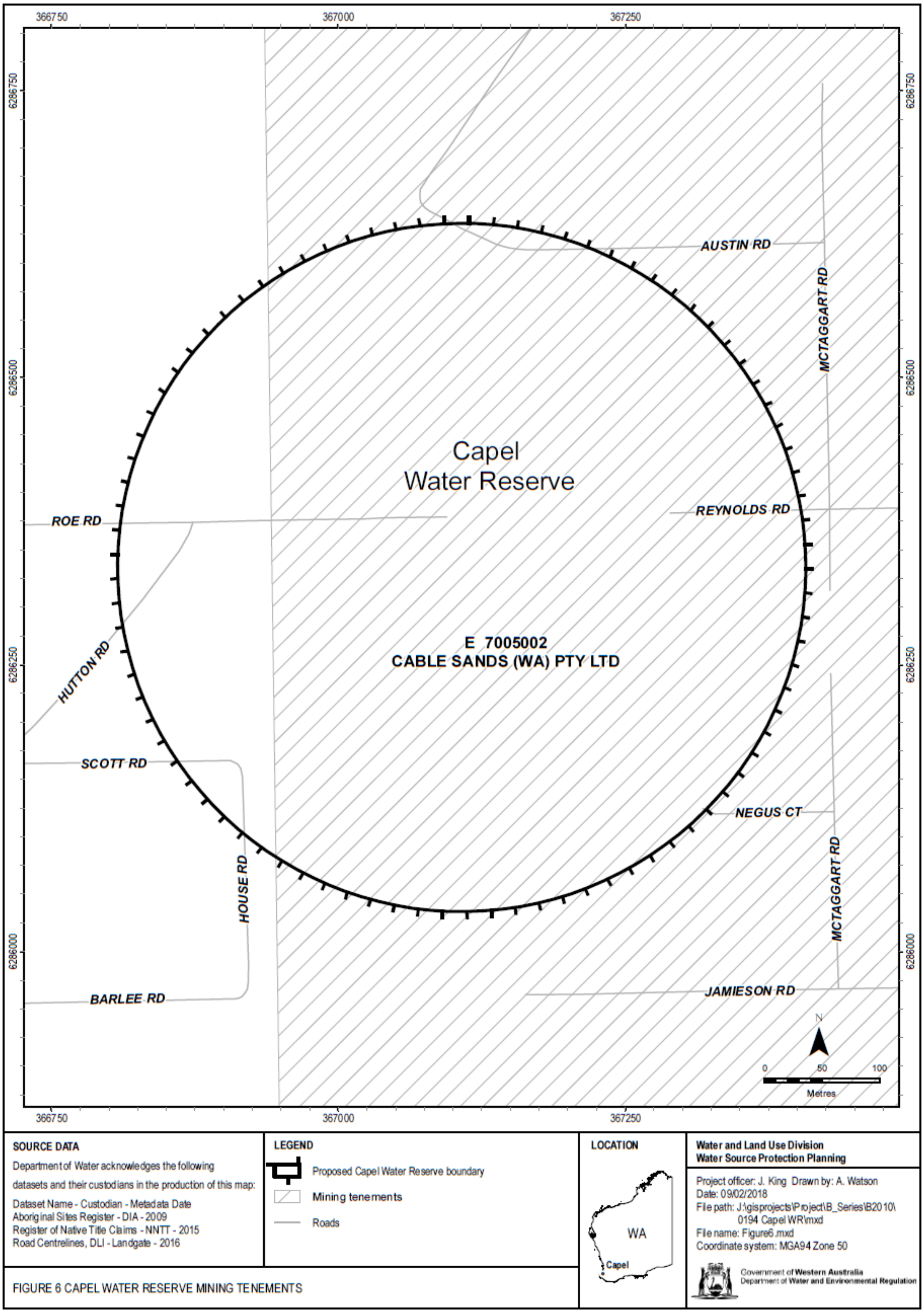

Figure A6 Proposed Capel Water Reserve – mining tenement

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 Capel bore field in accordance with the requirements of the *Australian drinking water guidelines* (ADWG) (NHMRC & NRMMC 2011) and interpretations agreed to with the Department of Health. This data shows the quality of water in the public drinking water source area (PDWSA). 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 Capel 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 November 2012 to October 2017.

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 Capel scheme refer to the most recent Water Corporation drinking water quality annual report at watercorporation.com.au.

Aesthetic characteristics

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

Table 2 Aesthetic detections for Capel bore field

Parameter	**Units**	**ADWG aesthetic guideline value***	**Capel bore field**	
			Range	**Median**
Aluminium (unfiltered)	mg/L	0.2	<0.008–0.01	<0.008
Chloride	mg/L	250	50–60	53.2
Colour (true)	TCU	15	<1–2	<1
Conductivity	mS/m	–	37–40	38.2
Hardness as $CaCO_3$	mg/L	200	44–50	46.9
Iron unfiltered	mg/L	0.3	*0.06–**7.4***	***4.6***
Manganese unfiltered	mg/L	0.1	<0.002–***0.16***	<0.002
pH measured in laboratory	no units	6.5–8.5	***6.41***–6.81	6.6
Silica	mg/L	80	14-16	14.4
Sodium	mg/L	180	44–49	46.4
Sulfate	mg/L	250	16–19	17.5
Total filterable solids by summation	mg/L	600	258–289	271.7
Turbidity	NTU	5	<0.1–***50***	<0.1

* 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 Capel 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.

Table 3 Health-related detections for Capel bore field

Parameter	**Units**	**ADWG health guideline value***	**Capel bore field**	
			Range	**Median**
Annual Radiation Dose	mSv	1	0.046^	0.046^
Fluoride	mg/L	1.5	0.15-0.25	0.18
Manganese unfiltered	mg/L	0.5	<0.002–0.16	<0.002
Radon-222	Bq/L	100	3.65^	3.65^
Sulfate	mg/L	500	16–19	17.5

^ Data derived from a single sample.

* 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 & ARMCANZ 2011).

† 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.

Microbiological contaminants

Microbiological testing of raw-water samples from Capel 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 reviewed period, positive *E. coli* counts were recorded in 1.7 per cent of samples. This equated to one positive detection of *E. coli* during the five-year reporting period.

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

Land use/activity	Potential water quality risks		Consideration for management	Current preventive measures	Recommended protection strategies
	Hazard	**Management priority**			
Special use (industrial) area					
Fuel and chemical storage	Hydrocarbons Toxic chemicals	Medium	Fuel and chemical storage is generally considered an incompatible activity within wellhead protection zones Existing land uses are permitted to continue operating	Groundwater quality monitoring	Adopt best management practices for chemical storage in a PDWSA: • WQPN no. 56: *Tanks for elevated chemical storage* • WQPN no. 65: *Toxic and hazardous substance : storage and use* • WQPN no. 10: *Contaminant spills – emergency response*.
Dairy processing and wastewater treatment	Nutrients Turbidity Toxic chemicals	Medium	Dairy processing plants are compatible in P3 areas	Groundwater quality monitoring	Adopt best management practices for processing and waste management:

Land use/activity	Potential water quality risks		Consideration for management	Current preventive measures	Recommended protection strategies
	Hazard	Management priority			
					• WQPN no. 12: *Dairy processing plants* • WQPN 22: *Irrigation with nutrient-rich wastewater* • WQPN 39: *Ponds for stabilising organic matter* Connection to deep sewerage when feasible
Car parks Vehicle use and maintenance	Hydrocarbons Turbidity	Medium	Current low levels of vehicle use	Groundwater quality monitoring	Adopt best management practices to manage contaminated stormwater: • WQPN 29: *Mobile mechanical servicing and cleaning* • WQPN 68: *Mechanical equipment wash down* • WQPN 52: *Stormwater management at industrial sites*

Land use/activity	Potential water quality risks		Consideration for management	Current preventive measures	Recommended protection strategies
	Hazard	**Management priority**			
Demolition and redevelopment works	Hydrocarbons Toxic chemicals Turbidity	Medium	Works have the potential to increase turbidity or contaminate stormwater by mobilising legacy hazardous and toxic substances	Groundwater quality monitoring	Adopt best management practices during works: • WQPN 52: *Stormwater management at industrial sites* • WQPN 10: *Contaminant spills - emergency response*
Septic tanks	Pathogens – human Nutrients	Medium	Depth of abstraction is greater than 130 m	Groundwater quality monitoring	Adopt best management practices and increase awareness of the Capel Water Reserve: • *Living and working in public drinking water source areas* brochure • WQPN no. 70: *Wastewater treatment and disposal – domestic systems*

Land use/activity	Potential water quality risks		Consideration for management	Current preventive measures	Recommended protection strategies
	Hazard	Management priority			
					Connection to deep sewerage or replacement with ATUs when the site is redeveloped
Water Corporation compound					
Water Corporation compound	Pathogens – small animals and insects	Medium	A pathogen detection in raw water was attributed to ingress of small animals or insects into the production bores	Production bores are now permanently sealed and capped to prevent ingress of small animals and insects Groundwater quality monitoring	Water Corporation site inspections and surveillance
Residential area					
Septic tanks	Pathogens – human Nutrients	Medium	There are relatively few houses within the water reserve Depth of abstraction is greater than 130 m	Groundwater quality monitoring	Adopt best management practices and increase awareness of the Capel Water Reserve:

Land use/activity	Potential water quality risks		Consideration for management	Current preventive measures	Recommended protection strategies
	Hazard	Management priority			
Gardens	Pesticide Nutrients	Medium	Gardens make up a relatively small proportion of the water reserve	Groundwater quality monitoring	• *Living and working in public drinking water source areas* brochure • WQPN no. 70: *Wastewater treatment and disposal – domestic systems*
Capel River and foreshore					
Foreshore management	Pesticides	Medium	Depth of abstraction is greater than 130 m Aquifer is semi-confined	Groundwater quality monitoring	Best management practices for pesticide use: • Public service circular 88: *Use of herbicides in water catchment areas*
Recreation	Pathogens – human	Medium	There are low levels of recreation within the water reserve Depth of abstraction is greater than 130 m	Groundwater quality monitoring	Increase awareness of the location of the Capel Water Reserve through signage and education

Land use/activity	Potential water quality risks		Consideration for management	Current preventive measures	Recommended protection strategies
	Hazard	**Management priority**			
Stock and cropping	Pathogens – domestic animals Pesticides Nutrients Pesticides	Medium	Depth of abstraction is greater than 130 m	Groundwater quality monitoring	Adopt best management practices and increase awareness of the Capel Water Reserve: • *Living and working in public drinking water source areas* brochure • WQPN no. 1: *Agriculture: dryland crops near sensitive water resources*
Roads and vehicles					
Vehicle use, storage and hydrocarbon spills	Hydrocarbons Heavy metals Turbidity	Medium	Relatively small number of vehicles in residential area Local traffic only within the water reserve	Groundwater quality monitoring	Increase awareness of the Capel Water Reserve: • *Living and working in public drinking water source areas* brochure Ensure groundwater quality issues are considered during incidents within the Capel Water

Land use/activity	Potential water quality risks		Consideration for management	Current preventive measures	Recommended protection strategies
	Hazard	Management priority			
					Reserve covered by Westplan–HAZMAT Catchment surveillance

Appendix D — Photographs

Photographs by J. King

Figure D1 Production bore 1/72 – permanently offline

Figure D2 Production bore 1/71

Figure D3 Production bore 2/16

Figure D4 Production bore 1/16

Figure D5 Self-bunded diesel generator

Figure D6 Fenced compound and signs

Appendix E — Summary of submissions

Summary of submissions for draft Capel Water Reserve water source protection plan

Issue	Response	Change to report
Potential effect of P3 area on residential subdivision (connected to deep sewerage)	Residential subdivisions connected to deep sewerage are acceptable land uses in P3 areas and will not be restricted by the proposed Capel Water Reserve.	Not required
Implications of Capel Water Reserve on new homes, e.g. restrictions on herbicide use, keeping animals and additional building requirements	The Capel Water Reserve will not impose any restrictions on residential land uses or activities in P3 areas. There will be no additional building requirements for new homes in the Capel Water Reserve. We recommend adopting best management practices to protect water quality, e.g. our *Living and working in public drinking water source areas* brochure	Not required

Appendix F — 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 an approach based on preventive risk and multiple barriers. 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.

An approach based on preventive risk 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 risk-based approach is often suggested as a way to address risks to water quality in a public drinking water source area (PDWSA; the area from which water is captured to supply drinking water). However, a risk-based approach is not the same as an approach based on preventive risk. A risk-based approach is inadequate for addressing risks to public health, and is not recommended by the ADWG.

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 PDWSA. 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.

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

An additional benefit from PDWSA protection is that it complements the state's conservation initiatives.

In Western Australia, the Department of Water and Environmental Regulation 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 legislative tools to protect water quality for PDWSAs. These Acts and the associated by-laws 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. Our Strategic policy: *Protecting public drinking water source areas in Western Australia* (Department of Water 2016a) describes how we do this. It is available www.dwer.wa.gov.au.

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.

Our Water quality protection note (WQPN) no. 25: *Land use compatibility tables for public drinking water source areas* (Department of Water 2016b) outlines appropriate development and activities within each of the priority areas (P1, P2 and P3).

With more than 120 constituted 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 Environmental Regulation) 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 www.dwer.wa.gov.au > what we do > water >urban water > drinking water, or read our Strategic policy: *Protecting public drinking water source areas in Western Australia* (Department of Water 2016a). You can also contact the Department of Water and Environmental Regulation's Water source protection planning branch on +61 8 6364 7600 or email drinkingwater@dwer.wa.gov.au.

Drinking water source protection reports produced by the Department of Water and Environmental Regulation

Drinking water source protection report	Scope and outcome	Consultation	Time to prepare	Implementation table	Gazettal
Drinking water source protection assessment (DWSPA)	Desktop assessment of readily available information	Preliminary	Up to 3 months	No	Arrange for the constitution and gazettal of the source under legislation. This helps protect water quality and guides land use planning. All types of consulted drinking water source protection reports can recommend to constitute a source's boundary under legislation.
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 G — 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 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 risk assessment process based on preventive risk 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, an assessment based on preventive risk 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. This is 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.

List of shortened forms

ABS	Australian Bureau of Statistics
ADWG	*Australian drinking water guidelines*
AEP	Annual exceedance probability
ANZECC	Australian and New Zealand Environment Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ATU	aerobic treatment unit
HAZMAT	hazardous materials
kL	kilolitre
km	kilometre
LEMC	local emergency management committee
m	metres
mg/L	milligram per litre
mL	millilitre
mm	millimetre
mSv	millisievert
mS/m	millisiemens per metre
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
TDS	total dissolved solids
WAPC	Western Australian Planning Commission
Westplan–HAZMAT	Western Australian plan for hazardous materials

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, e.g. appearance, taste and odour (NHMRC & NRMMC 2011).
Allocation	The quantity of water that a licensee is permitted to abstract is their allocation, usually specified in kilolitres per annum (kL/a).
Aquifer	An aquifer is a geological formation or group 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 Bibliography).
Bore	A bore is a narrow, lined hold drilled into the ground to monitor or draw groundwater (also called a well).
Bore field	A group of bores to monitor or withdraw groundwater is referred to as a bore field (also see *wellfield*).
Catchment	The physical area of land which intercepts rainfall and contributes the collected water to surface water (streams, rivers, wetlands) or groundwater.
Confined aquifer	An aquifer that is confined between non-porous rock formations (such as shale and siltstone) and therefore contains water under pressure.
Drinking water source protection report	This is a report on water quality hazards and risk levels within a public drinking water source area that includes recommendations to avoid, minimise, or manage those risks for the protection of the water supply in the provision of safe drinking water supply.
Effluent	Effluent is treated or untreated liquid, solid or gaseous waste discharged by a process such as through a septic tank and leach drain system.
Electrical conductivity	This estimates the volume of TDS or the total volume of dissolved ions in a solution (water) corrected to 25ºC. Measurement units include millisiemens per metre and microsiemens per centimetre.

Gigalitre	A gigalitre is equivalent to 1 000 000 000 litres or one million kilolitres.
Half-life	The time required for one half of a sample of material to disintegrate.
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.
Hydrogeology	The study of groundwater, especially relating to the distribution of aquifers, groundwater flow and groundwater quality.
Leaching/ leachate	The process by which materials such as organic matter and mineral salts are washed out of a layer of soil or dumped material by being dissolved or suspended in percolating rainwater. The material washed out is known as leachate. Leachate can pollute groundwater and waterways.
mg/L	A milligram per litre (0.001 grams per litre) is a measurement of a total dissolved solid in a solution.
Millisievert	A millisievert is a measure of annual radiological dose, with a natural dose equivalent to 2 mSv/yr.
Millisiemens per metre	Millisiemens per metre is a measure of electrical conductivity of a solution or soil and water mix that provides a measurement of salinity.
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.
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.
Porosity	The state of quality of a material to be porous – that is permeable by water.
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* and 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.
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.
Semi-confined aquifer	A semi-confined aquifer or leaky aquifer is saturated and bounded above by a semi-permeable layer and below by a layer that is either impermeable or semi-permeable.
Stormwater	Rainwater that has run off the ground surface, roads, paved areas etc., and is usually carried away by drains.
Total dissolved solids	Total dissolved solids consist of inorganic salts and small amounts of organic matter that are dissolved in water. Clay particles, colloidal iron and manganese oxides, and silica fine enough to pass through a 0.45 micrometer filter membrane can also contribute to total dissolved solids. Total dissolved solids comprise sodium, potassium, calcium, magnesium, chloride, sulfate, bicarbonate, carbonate, silica, organic matter, fluoride, iron, manganese, nitrate (and nitrite) and phosphate (NHMRC & NRMMC 2011).

Total filterable solids by summation Total filterable solids by summation is a water quality test which is a total of the following ions: Na (sodium), K (potassium), Ca (calcium), Mg (magnesium), Cl equivalent (chloride), alkalinity equivalent, SO_4 equivalent (sulfate) or S (sulfur) in grams, Fe (iron), Mn (manganese), and SiO_2 (silicon oxide). It is used as a more accurate measure than total dissolved solids (TDS). The higher the value, the more solids that are present and generally the saltier the taste.

Treatment Application of techniques such as settlement, filtration and chlorination to render water suitable for specific purposes, including drinking and discharge to the environment.

True colour units True colour units are a measure of degree of colour in water.

Turbidity The cloudiness or haziness of water caused by the presence of fine suspended matter.

Unconfined aquifer An aquifer in which the upper surface of water is lower than the top of the aquifer itself. The upper surface of the groundwater within the aquifer is called the watertable. This is also known as a superficial aquifer.

Wastewater Water that has been used for some purpose and would normally be treated and discarded. Wastewater usually contains significant quantities of pollutant.

Water quality Water quality is the collective term for the physical, aesthetic, chemical and biological properties of water.

Water reserve A water reserve is an area proclaimed under the *Country Areas Water Supply Act 1947* 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.

Wellfield A wellfield is a group of bores located in the same area used to monitor or withdraw groundwater.

Wellhead The top of a well (or bore) used to draw groundwater is referred to as a wellhead.

Wellhead protection zone A wellhead protection zone is usually declared around wellheads in public drinking water source areas to protect the groundwater from immediate contamination threats in the nearby area.

Western Australian hazardous materials emergency management scheme	This is now known as Westplan–HAZMAT.

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