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

Dardanup Water Reserve

drinking water source protection plan

Dardanup town water supply

Water resource protection series
Report WRP 185
June 2018

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ISSN 1835-3924 (online)

Acknowledgements

The Department of Water and Environmental Regulation would like to thank the following for their contribution to this publication: Vivien Claughton, Andrew Watson and Stephen Watson (Department of Water and Environmental Regulation) and Hilary Manikkathiagarajah (Water Corporation).

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Cover photograph: Aerial photo of Dardanup Water Reserve

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Summary

Dardanup is a small town about 185 km south of Perth and 13 km south-east of Bunbury. The town is a support centre for the surrounding dairy and beef industries.

The town water supply is derived from two Water Corporation production bores. The bores abstract water from the upper Leederville aquifer which is recharged directly from rainfall on the Blackwood plateau to the south-east.

There is a low risk of contamination from land uses surrounding the bore field because of the semi-confined nature of the aquifer. The surrounding land uses include rural houses and their surrounding agricultural land and Crown land vested for recreation and leased to the Dardanup Equestrian Centre.

The Dardanup Water Reserve is not currently gazetted. The proposed boundaries and priority areas assigned in this plan will provide an appropriate level of protection for Dardanup's drinking water source.

Some recommended protection strategies are:

- The land in the water reserve is assigned as priority 1 (P1), priority 2 (P2) and priority 3 (P3) areas based on existing land uses and zoning.
- The water reserve boundary, priority areas and protection zone need to be recognised in the Shire of Dardanup's town planning scheme and other applicable schemes and strategies.
- Best management practices for existing or future bore construction in close proximity to the water reserve should be implemented.
- Best management practices should be employed for existing and future land uses within the water reserve.

This plan was prepared in consultation with landowners, the Shire of Dardanup, the Water Corporation and the managers of the Dardanup Equestrian Centre.

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.*

Important information about the Dardanup Water Reserve is in Table 1.

Table 1 Key information about the Dardanup Water Reserve

Dardanup Water Reserve	
Local government authority	Shire of Dardanup
Location supplied	Dardanup
Population supplied	429 (Australian Bureau of Statistics 2011)
Water service provider	Water Corporation
Aquifer type	Semi-confined Screened in the Leederville aquifer from 47 m to 59 m
Licensed abstraction	75 000 kL per year
Number of bores	Two
Bore names and GPS coordinates	1/80 (E 384 032, N 6 302 307, zone 50) 2/80 (E 384 052, N 6 302 307, zone 50)
Date of bore completion	1980
Water treatment	Aerated, treated with soda ash to balance the pH and chlorinated to remove microbes
Dates of drinking water source protection reports	2018 – *Dardanup Water Reserve drinking water source protection plan* (this document)
Consultation	2017 – mail out to all landowners, and consultation with key stakeholders as part of the development of the drinking water source protection plan
Gazettal status	Gazettal of this source is proposed under the *Country Areas Water Supply Act 1947* after this report 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)

1 Overview

1.1 The drinking water supply system

The Water Corporation provides drinking water to the town of Dardanup, which has a population of 429 (Australian Bureau of Statistics 2011). The total number of services supplied is 207, including 182 domestic properties (Water Corporation 2015).

The Dardanup Water Reserve bore field is approximately 1 km south of Dardanup and is the sole supply for the town (see Figure A1). The two production bores are screened in the Leederville aquifer from 47 m to 59 m and draw water from a semi-confined aquifer.

The water is abstracted then aerated before being stored in two tanks (see figures A2 and D2). The water is then treated with soda ash to balance the pH before being chlorinated and transferred to an elevated tank (see Figure D2) to supply the town via a gravity-fed pipe network.

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 public drinking water source areas, read Appendices E, F and G.

1.2 Characteristics of the catchment

1.2.1 Physical environment

The Dardanup Water Reserve is within the southern part of the Swan Coastal Plain. The landscape is dominated by grassed paddocks with some dispersed sections of native Eucalyptus vegetation (see figures D3 to D8). The topography of the area is quite flat and the surface drainage is non-perennial, gently running to the north-west.

1.2.2 Climate

The area has a Mediterranean-type climate, characterised by warm, dry summers and cool, wet winters. At the nearby site of Bunbury, since 1996 the mean monthly maximum temperature has ranged from 17.2^{o}C in July to 30.1^{o}C in February, and the mean monthly minimum temperature has ranged from 7^{o}C in July to 15.9^{o}C in February (Bureau of Meteorology 2017).

Average annual rainfall for Dardanup (since 1936) is 914 mm, mostly occurring during the winter months (Bureau of Meteorology 2017).

1.2.3 Hydrogeology

The production bores are screened in the Leederville aquifer at a depth of 47–59 m. The superficial formation in the area is Guilford Clay and the Leederville aquifer in the region is Mowen and/or Upper Vasse Member.

This means that the Leederville aquifer is semi-confined in the region of the Dardanup production bores.

1.3 Water management

1.3.1 Licence to take water

Water resource use and conservation in Western Australia is administered by the Department of Water and Environmental Regulation (DWER) 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 (e.g. pumping water from a bore) within proclaimed groundwater areas throughout the state. Some exemptions apply such as abstracting water for domestic purposes only.

The Dardanup Water Reserve is located within the Bunbury Groundwater Area (within the Dardanup subarea) which is proclaimed under the act. The Water Corporation is licensed by DWER to abstract water from the Bunbury Groundwater Area for public water supply.

The annual town water supply abstraction for the 2014/15 year was just under 50 000 kL (Water Corporation 2015). The Water Corporation allocation for the Dardanup Water Reserve is 75 000 kL/year and the licence is due to expire on 31 December 2018.

1.3.2 Water supply planning

In 2014, the previous Department of Water (DoW) released the report *Water resources inventory: Water availability, quality and trends*. The report states that within the Dardanup subarea in the shallow Perth – Superficial Swan aquifer there is an allocation limit of 290 ML/year with no further water available and that the water level trend is declining. In the Dardanup subarea of the deeper Perth – Leederville aquifer, the report stated that there is an allocation limit of 3500 ML/year and there is a further 1 ML/year available but the water trend level is declining.

In 2009, the department released the *South West groundwater areas allocation plan.* This plan includes Dardanup and its surrounds. Two evaluation statements associated with the plan have been released, covering the periods 2009–2012 and 2012–2015. The latest evaluation statement noted *“there is enough water licensed and reserved to meet projected water demands to 2030 and beyond”*.

The Water Corporation's *Dardanup groundwater monitoring review 2009–2015* discusses future water trends, and estimates that the current Water Corporation allocation should be sufficient beyond 2019–2020. Each year (2008–09 to 2014–15), the annual draw was approximately 75 per cent of the licensed allocation (except for one year where the allocation was exceeded due to a leak that was later identified and fixed).

There are plans in the Shire of Dardanup's local planning strategy for additional residential land, but this growth is less than that planned for by the Water Corporation, and they have calculated that this increase will not be achieved until 2050. Therefore the current water supply is sufficient beyond 2019–20.

1.4 How is this drinking water source currently protected?

The Water Corporation regularly patrols and surveys the borefield to identify risks to water quality. Once the boundary is proclaimed, by-law enforcement powers under the Country Areas Water Supply By-laws 1957 will be delegated to the Water Corporation (see section 3.6). The Water Corporation can currently prosecute within production bore compounds under the Water Services Regulations 2013.

The Shire of Dardanup's *Local planning strategy 2015* recognises that the Water Corporation has public drinking water production bores that require protection, however the water reserve is not defined as a special control area. This plan recommends that the shire recognise Dardanup Water Reserve as a special control area (see section 3.4).

Please read Appendix E for more information about how we protect public drinking water sources.

1.5 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 within the Dardanup Water Reserve are appropriately located and constructed to prevent contamination of the public drinking water source. This will be assessed through 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). It is important that location coordinates for all bores are recorded correctly, to ensure proper assessment of the risk to the drinking water bores.

There is one other licensed user within the Dardanup Water Reserve.

1.6 Aboriginal sites of significance and native title claims

Aboriginal sites of significance are important places with special cultural connections to Aboriginal people because they link Aboriginal cultural tradition to place, land and people over time. These sites are integral to the lives of Aboriginal people, and are found in urban, rural and remote areas. They are most common near rivers, lakes, swamps, hills and the coast. The *Aboriginal Heritage Act 1972* protects all Aboriginal places and objects that are culturally important to Aboriginal people. It is against the law to disturb a site or to remove artefacts.

There are no Aboriginal sites of significance within the Dardanup Water Reserve.

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 Dardanup Water Reserve – the Gnaala Karla Booja claim (WAD6274/1998).

The State Government of Western Australia and the Noongar native title claimants have negotiated the South West Native Title Settlement. The Settlement recognises 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 A5).

The settlement includes six identical Indigenous Land Use Agreements (ILUAs). The agreements enable some types of land-based customary activities to be undertaken by Noongar people in PDWSAs within the South West Settlement Area. The department amended two sets of by-laws (Metropolitan Water Supply, Sewerage and Drainage By-laws 1981 and the Country Areas Water Supply By-laws 1957) on 8 June 2016 to enable Noongar people to undertake some of these land-based activities:

- entry to registered Aboriginal sites in reservoir protection zones for customary purposes
- designation of camping sites for Noongar people (outside reservoir protection zones and wellhead protection zones)
- 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. Refer to Water quality information sheet 39: *Aboriginal customary activities in public drinking water source areas in the South West Native Title Settlement Area* (DoW 2017).

DWER 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.

1.7 Water quality information

The Water Corporation has provided updated water quality information for the Dardanup Water Reserve (see Appendix B). The values were taken from ongoing monitoring for the period November 2012 to October 2017.

The raw water quality of the Dardanup Water Reserve is good, however during the review period it was outside the ADWG's aesthetic guideline range for pH. In addition, *Escherichia coli* was detected in 3.2 per cent of samples; a total of 4 detections. The source of the *E. coli* is unknown however it is possible that it was due to poorly sealed headworks allowing insects and small animals into the headworks. The headworks were temporality sealed in 2014 and then permanently sealed in 2017.

It is important to appreciate that this raw-water data 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.

2 Contamination risks in this drinking water source

2.1 Water quality risks

As part of this plan, DWER has conducted an updated assessment of water quality contamination risks in the Dardanup Water Reserve in accordance with the ADWG. Table 2 shows the risks that are considered medium to high.

Refer to Appendix E for information about typical contamination risks in PDWSAs. Refer to Appendix G to gain a greater understanding about the risk assessment process we use.

As Dardanup's public drinking water is drawn from a semi-confined groundwater source, there is a lower potential for contamination from surrounding land uses. This is because the source is protected from surface contamination by the considerable depth to the groundwater and the presence of a semi-confining layer that sits above the groundwater, acting as a partial barrier to contamination.

2.1.1 Shale and tight gas

The Dardanup Water Reserve is within the Perth basin. The Perth basin is a prospective shale and tight gas area. Therefore, any proposals for the extraction of shale or tight gas within the Dardanup Water Reserve or within 5 km of any drinking water bore should be referred to DWER for comment. This is consistent with the *Administrative agreement between the Department of Mines and Petroleum and Department of Water for onshore petroleum and geothermal activities in WA* (DoW and Department of Mines and Petroleum 2015).

Oil or gas exploration and production is to be managed in accordance with this administrative agreement, as well as government's response to *Report 42: Implications for Western Australia of hydraulic fracturing for unconventional gas* (Legislative Council Standing Committee on Environment and Public Affairs 2015) and *Guide to the regulatory framework for shale and tight gas in WA: A whole-of-government approach* (Government of Western Australia 2015).

The proposed boundary and priority area amendments will not require any change to the way the administrative agreement and regulatory framework are implemented.

2.2 Land uses and activities

The Dardanup 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. Table 2, at the end of this section, summarises this information in an easy-to-read format. Appendix C displays a more detailed risk assessment, and includes recommended protection strategies to address water quality risks.

The private land within Dardanup Water Reserve is zoned ‘rural’ in the Shire of Dardanup’s *Local planning strategy 2015*, which identifies that this land shall have no further subdivision.

2.2.1 Crown reserve

There are various tenures of Crown land within the Dardanup Water Reserve. There are road reserves (including a parcel of native bushland), a railway reserve and the land vested with the Shire of Dardanup which is leased to the Dardanup Equestrian Centre.

Roads and tracks

There are several roads and tracks on Crown land within the water reserve. A number of sealed bitumen roads run though the reserve (see Figure D4). Vehicles travelling on roads within the water reserve pose a hydrocarbon contamination risk to the water source from leaks, spills or accidents. This risk can be reduced by ensuring any hydrocarbon spills are cleaned up immediately.

There is also a parcel of native bushland which is vested as a road reserve.

Dardanup Equestrian Centre

The Dardanup Water Reserve is partially located on Crown land which is vested in the Department of Lands and the Shire of Dardanup for recreation, and is zoned 'general farming' in the Shire of Dardanup's *Town planning scheme no. 3* (see Figure D5).

Large numbers of people attend special events at the Dardanup Equestrian Centre, which can pose a pathogen risk to the source. Significant ‘paddock parking’ occurs which causes erosion, contributing to turbidity, and poses a hydrocarbon risk from leaks, spills or accidents caused by vehicles. At other times, access to the Dardanup Equestrian Centre is gated and illegal access is low.

Horses also cause erosion, contributing to turbidity. The horses' manure also poses a risk of nutrient and pathogen contamination to the drinking water source. To help manage this risk, the equestrian centre collects manure from the paddocks and stores it on cement hardstands (see Figure D6) before transporting it offsite.

The centre sub-leases some of its land for cattle grazing (see Figure D7), which also poses a risk of nutrient and pathogen contamination to the drinking water source. However, due to low stocking rates, and the fact that the bores are on a raised hardstand within fenced compounds that keep stock out, this risk is lowered.

Railway

A railway line runs through the Dardanup Water Reserve. The railway is not currently used. The main water quality contamination risk associated with the railway is pesticide contamination from weed management occurring within the railway reserve.

Water treatment plant

The Water Corporation's water treatment plant and production bores (see Figure D1) are located on Crown land which is vested with the Water Corporation. This land is fenced and located on a raised hardstand (See Figure D3), reducing the risk of contamination because potentially contaminated water does not flow into the compound from surrounding areas.

2.2.2 Private land

The private land within the Dardanup Water Reserve is zoned ‘rural’ (see Figure D8), with predominant land uses being farm houses, stock grazing, irrigated pasture (including flood irrigation) and cropping.

Risks to the water source from rural areas include pathogen and nutrient contamination from septics, on-site wastewater disposal and animal waste. There is also a nutrient and chemical contamination risk from fertiliser and pesticide use as well as hydrocarbon contamination from oil and fuel leaks and spills.

Table 2 Summary of potential water quality risks, land use compatibility and best management practices

Land use/activity	Hazard	Management priority	Compatibility of land use/activity	Best management practice guidance[1]
Rural land	Pathogens from septic tanks	Medium	Existing houses are acceptable in P2 and P3 areas. See WQPN no. 25: *Land use compatibility tables for public drinking water source areas* for compatibility of lot sizes for subdivision.	Regular inspection and maintenance of septic tank systems
Stock grazing (i.e. cattle and horses)	Pathogens from animal excrement	Medium	Stock grazing is compatible with conditions in P2 areas.	WQPN no. 35: *Pastoral activities within rangelands*
Equestrian centre – septic tanks	Pathogens from septic tanks	Medium	Equestrian centres are acceptable in P3 areas.	Water quality protection guidelines no. 13: *Environmental guidelines for horse facilities and activities* Water quality awareness brochure: *Managing horses in semi-rural environments*
Equestrian centre – stock grazing	Pathogens from animal faeces	High	Stock grazing is acceptable in P3 areas.	

[1]Water quality protection notes are available www.dwer.wa.gov.au.

3 Protecting your drinking water source

The objective of this plan is to preserve water quality at its current level and where practical, achieve an improvement, to ensure continued supply of safe, good quality drinking water to the town of Dardanup.

3.1 Proclaiming public drinking water source areas

Dardanup Water Reserve has not yet been proclaimed under the *Country Areas Water Supply Act 1947*. In order to protect the quality of this drinking water source, we are proposing to proclaim it.

The proclamation process begins with consultation during the development of a drinking water source protection report, such as this document, which recommends to proclaim the proposed Dardanup Water Reserve under the *Country Areas Water Supply Act 1947*.

Once the water reserve is proclaimed, the local government authority should incorporate the 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 (see section 3.5) 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 DWER does not recommend land use intensification in a PDWSA because of the increased risks to water quality and public health.

For more guidance on appropriate land uses and activities please refer to our WQPN no. 25: *Land use compatibility tables for public drinking water source areas*.

3.2 Defining priority areas

The protection of PDWSAs relies on statutory and non-statutory measures for water resource management and land-use planning. DWER'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. See Figure A3 for a map of land tenure within the Dardanup Water Reserve. For further detail, please refer to our WQPN no. 25: *Land use compatibility tables for public drinking water source areas*.

The proposed priority areas for the Dardanup Water Reserve have been determined in accordance with current DWER policy. These areas are described below and displayed in Figure A2. Our WQPN no.25: *Land use compatibility tables for public drinking water source areas* outlines activities that are 'acceptable', 'compatible with conditions' or 'incompatible' within the different priority areas. For an explanation of the background and support for protection of PDWSAs, please refer to Appendix F.

We propose to assign the Crown land in the Dardanup Water Reserve (this includes the Water Corporation land, the native bushland parcel and the road reserve) as P1 because:

- water from this source is the only supply available to the town of Dardanup so it needs to be afforded the highest possible level of protection
- current land uses on this land are considered 'compatible with conditions' in P1 areas.

We propose to assign the southern section and the northern section of the eastern side of the water reserve as P2 because:

- existing land uses are considered 'compatible with conditions' provided best management practices are applied
- the land is privately owned and is zoned rural
- the local planning strategy identifies these areas for no further subdivision.

We propose to assign the land north of Garvey Road and west of Boyanup-Picton Road as P3 because:

- the local planning strategy has identified this area for rural-residential, which may result in further subdivision in the future
- the current land use, 'equestrian centres', is considered 'acceptable' in P3 areas.

3.3 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.

Wellhead protection zones (WHPZs) are generally circular (unless information is available to determine a different shape or size), with a 500 m radius around each production bore in a P1 area and a 300 m radius around each production bore in P2

and P3 areas. WHPZs do not extend outside the boundary of the water reserve and they adopt the priority area of the land over which they occur.

Due to the semi-confined nature of the aquifer we are proposing that the water reserve only extends as far as the wellhead protection zone (see Figure A2). Therefore the wellhead protection zone will cover the whole of the Dardanup Water Reserve.

3.4 Planning for future land uses

Appropriate protection mechanisms in statutory land-use planning processes are necessary to secure the long-term protection of drinking water sources. As outlined in the Western Australian Planning Commission's State planning policy no. 2.7: *Public drinking water source policy* (2003) it is appropriate that the Dardanup Water Reserve, its priority areas and protection zone be recognised in the Shire of Dardanup's local planning scheme. Any development proposals in the Dardanup Water Reserve that are inconsistent with advice in our WQPN no. 25: *Land use compatibility tables for public drinking water source areas* or recommendations in this plan, need to be referred to our nearest regional office for advice.

For further information on the integration of land-use planning and water source protection, please refer to Appendix F.

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 3.5).

3.5 Using best management practices

There are opportunities to reduce water contamination risks by carefully considering design and management practices. To help protect drinking 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 relevant to the Dardanup Water Reserve include (see *Further reading*):

- WQPN no. 44: *Roads near sensitive water resources*
- WQPN no. 10: *Contaminant spills – emergency response*
- WQPN no. 33: *Nutrient and irrigation management plans*
- WQPN no. 80: *Stockyards*

- Water quality protection guidelines no. 13: *Environmental guidelines for horse facilities and activities*
- Water quality awareness brochure: *Managing horses in semi-rural environments*.

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

3.6 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.

Water service works (such a bore compounds of public drinking water sources) are also protected under the *Water Services Act 2012* and the Water Services Regulations 2013.

DWER considers by-law enforcement, through surveillance of land-use activities in PDWSAs, to be an important mechanism to protect water quality.

Once this source is proclaimed, signs will be erected on the boundary of the water reserve to educate and advise the public about activities that are prohibited or regulated. There are already signage around the production bore compound but this should be expanded to the whole water reserve.

This plan recommends that the Water Corporation implement by-law enforcement under the existing delegation arrangement (see section 4, recommendation no. 6). This also includes:

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

3.7 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 Dardanup local emergency management committee, through the South West emergency management district, should be familiar with the location and purpose of the Dardanup 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 Dardanup Water Reserve.

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

3.8 Implementing and updating this plan

Table 2 (see the end of section 2) identifies some potential water quality risks associated with existing land uses in the Dardanup Water Reserve. Further information and the recommended protection strategies to deal with those risks and others are outlined in Appendix C.

With more than 130 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 or in response to changes in water quality contamination risks as in some locations, 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.

4 Recommendations

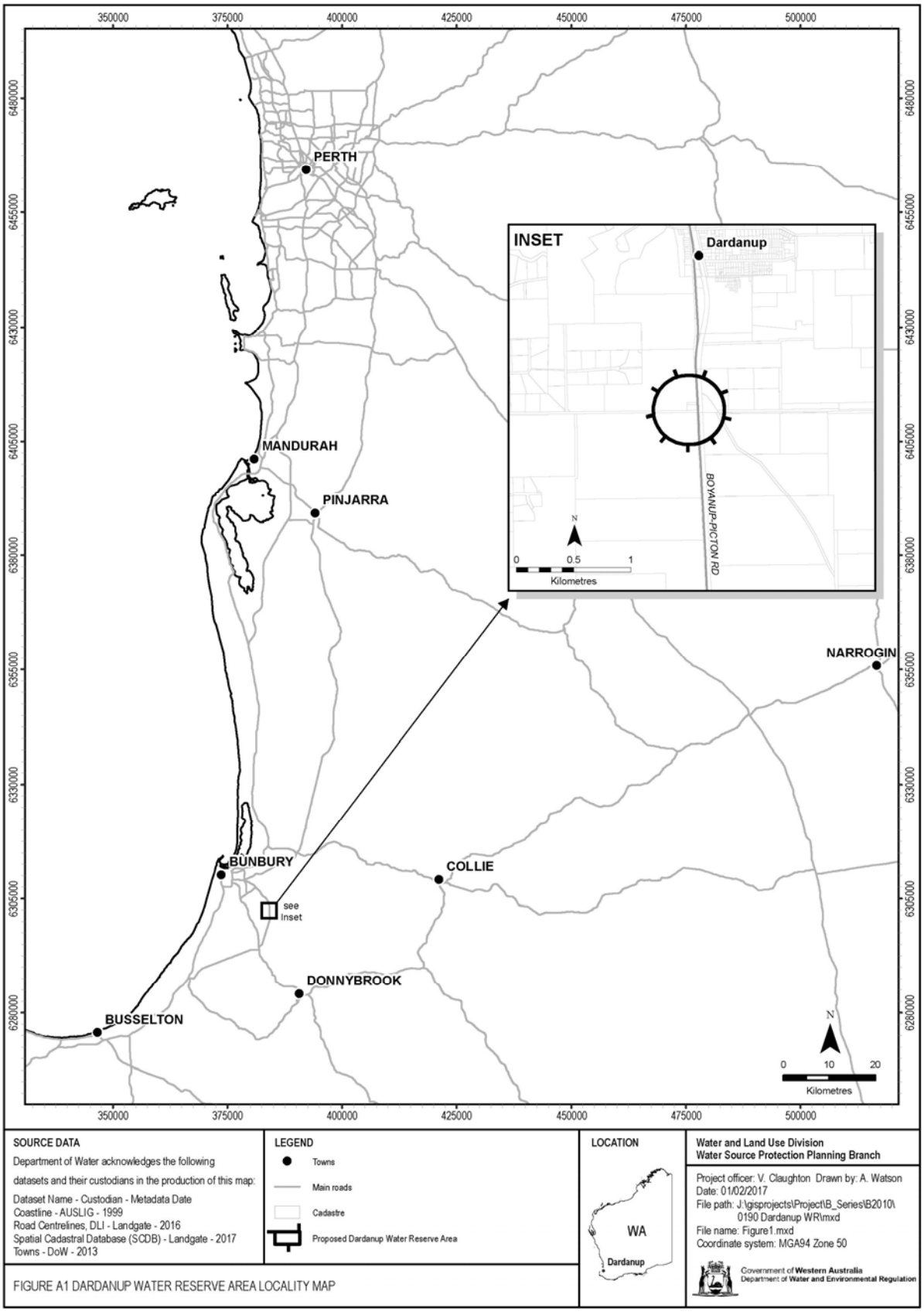
Based on the findings of this plan, the following recommendations will now be applied to the Dardanup Water Reserve. The bracketed stakeholders are those expected to have a responsibility for, or an interest in, the implementation of that recommendation.

1. Proclaim the Dardanup Water Reserve under the *Country Areas Water Supply Act 1947*. (DWER)
2. Incorporate the findings of this plan and the location of the Dardanup Water Reserve (including its priority areas and protection zones) in the Shire of Dardanup's 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 Dardanup)
3. Refer development proposals within the Dardanup Water Reserve that are inconsistent with DWER's WQPN no. 25: *Land use compatibility tables for public drinking water source areas* or recommendations in this plan to the DWER regional office for advice. (Department of Planning, Shire of Dardanup, proponents of proposals)
4. Ensure incidents covered by Westplan–HAZMAT in the Dardanup Water Reserve are addressed by ensuring that:
    - the Shire of Dardanup local emergency management committee is aware of the location and purpose of the Dardanup Water Reserve
    - the locality plan for the Dardanup 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 Dardanup Water Reserve
    - personnel dealing with Westplan–HAZMAT incidents in the area have ready access to a locality map of the Dardanup Water Reserve and information to help them recognise the potential impacts of spills on drinking water quality.

    (Water Corporation, DWER)
5. Erect signs along the boundary of the Dardanup 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, and expand the inspections and by-law enforcement to cover the new water reserve boundary. (Water Corporation)
7. This report will be reviewed in seven years or in response to changes in water quality contamination risks. (DWER)

Appendices

Appendix A — Figures



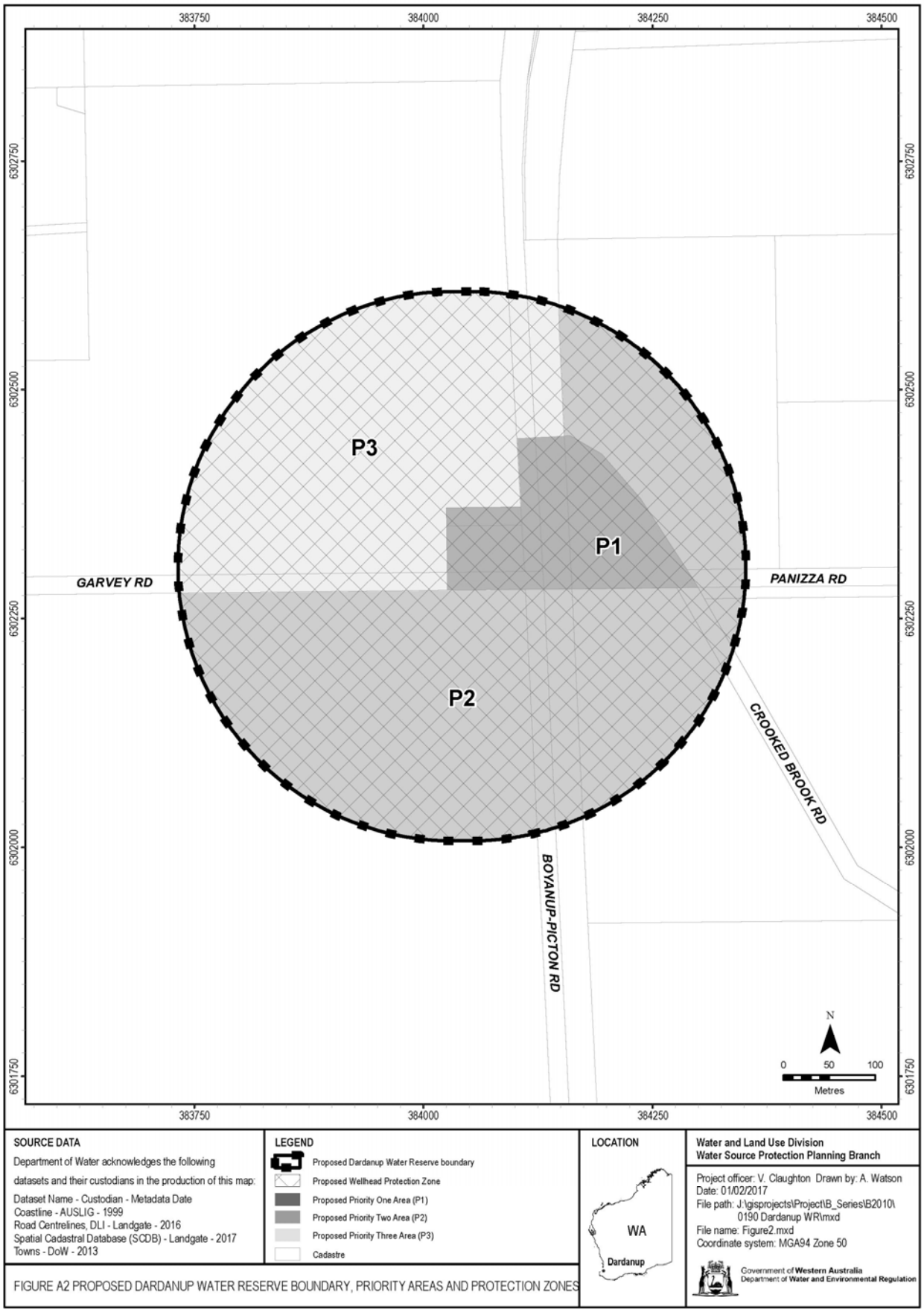


FIGURE A2 PROPOSED DARDANUP WATER RESERVE BOUNDARY, PRIORITY AREAS AND PROTECTION ZONES

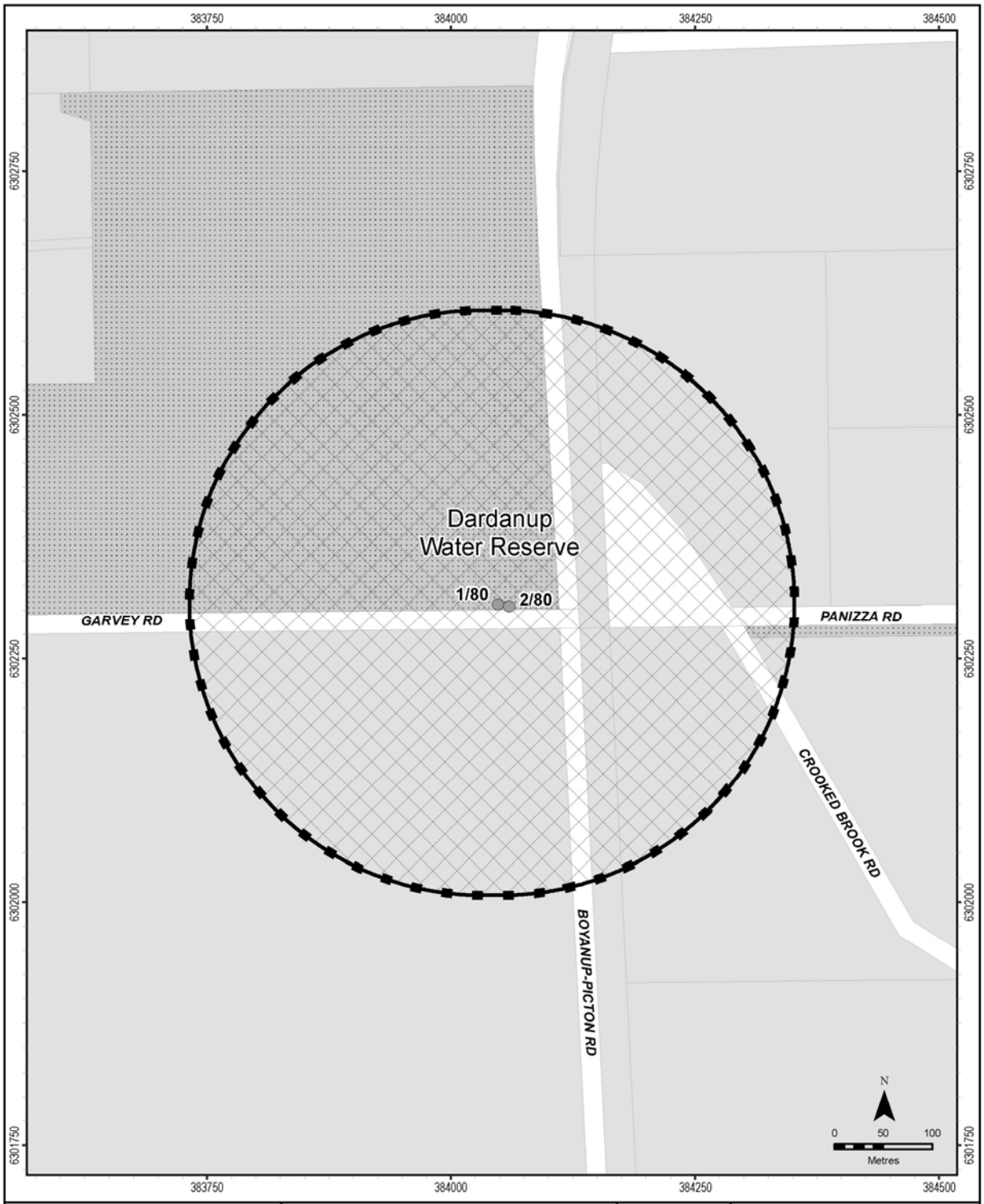
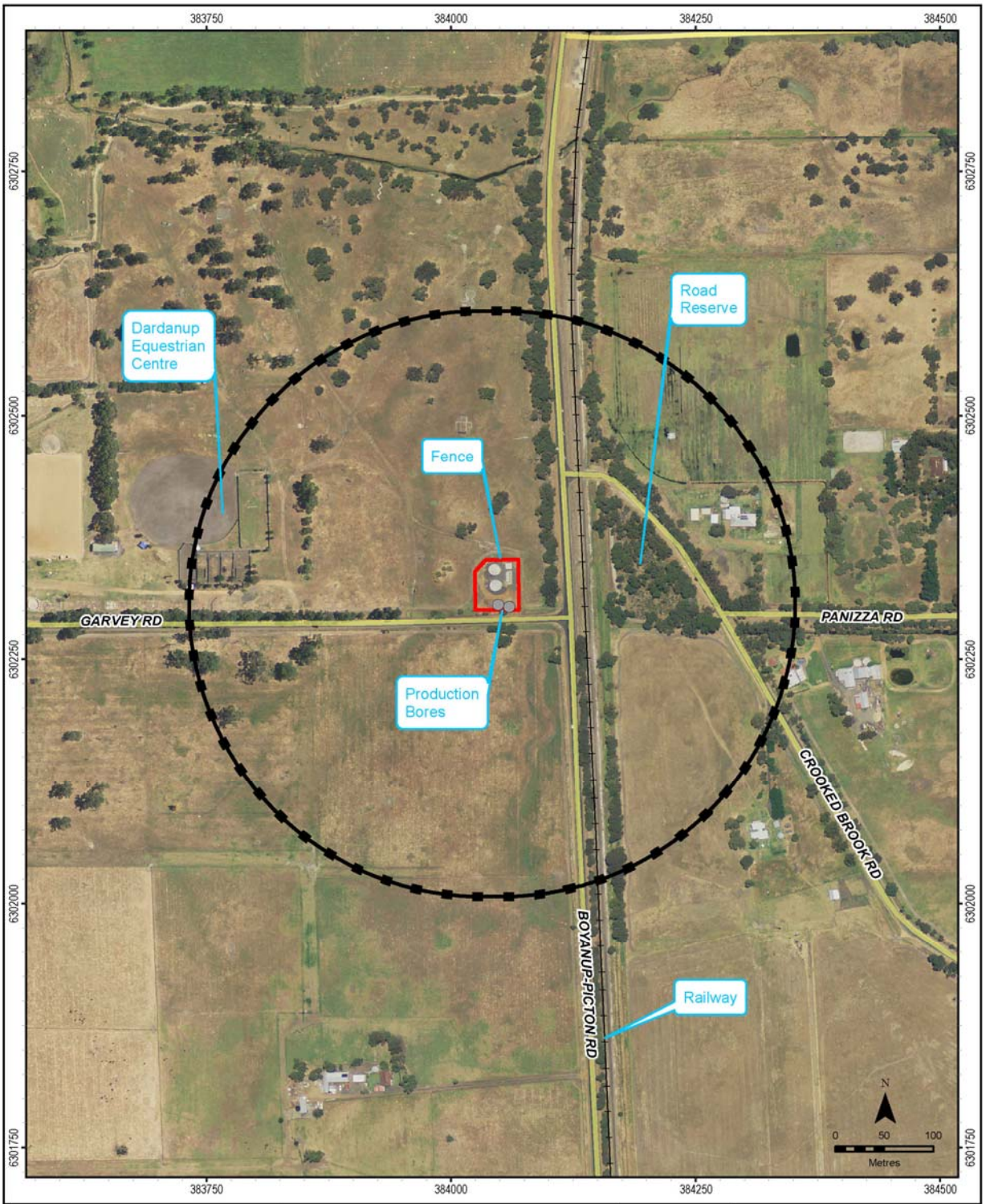


FIGURE A3 LAND USE, ACTIVITIES AND TENURE IN AND AROUND THE DARDANUP WATER RESERVE



SOURCE DATA

Department of Water acknowledges the following datasets and their custodians in the production of this map:
Dataset Name - Custodian - Metadata Date
Bunbury 2013 50cm z50 - Landgate - 2013
Coastline - AUSLIG - 1999
Road Centrelines, DLI - Landgate - 2016
Spatial Cadastral Database (SCDB) - Landgate - 2017
Towns - DoW - 2013

LEGEND

- Proposed Dardanup Water Reserve boundary
- Fence
- Roads
- Railway
- Production bores

LOCATION

Water and Land Use Division
Water Source Protection Planning Branch

Project officer: V. Claughton Drawn by: A. Watson
Date: 27/03/2018
File path: J:\gisprojects\Project\B_Series\B2010\0190 Dardanup WR\mxd
File name: Figure4.mxd
Coordinate system: MGA94 Zone 50

Government of Western Australia
Department of Water and Environmental Regulation

FIGURE A4 AERIAL PHOTOGRAPHY AND LAND USES IN THE DARDANUP WATER RESERVE

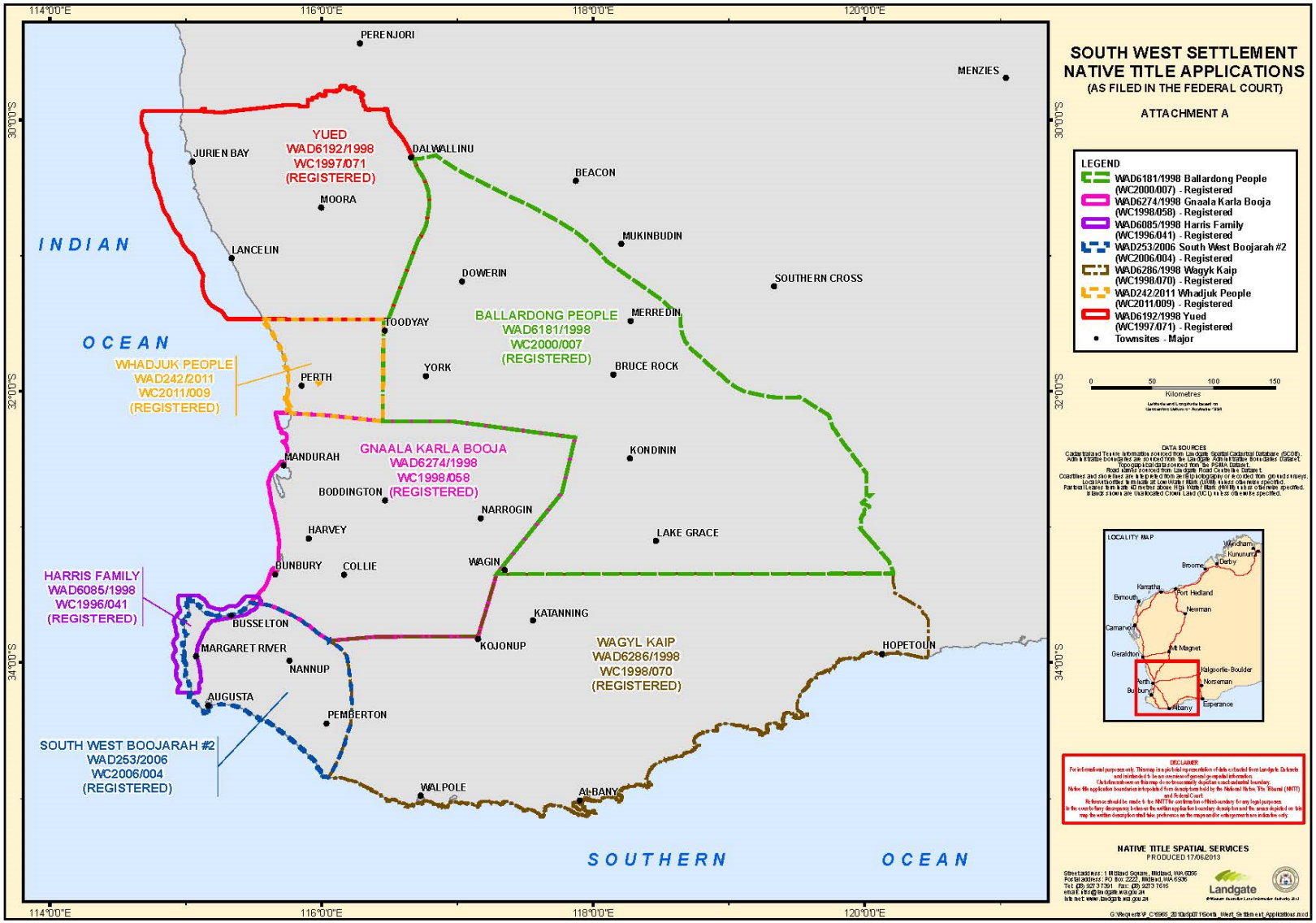


Figure A5 South West Native Title Agreement area (source: Department of Premier and Cabinet)

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 Dardanup borefield 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 Dardanup bore field. The raw water data presented are derived from the combination of two production bores (1/80 and 2/80). 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 Dardanup 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 Dardanup bore field are summarised in the following table.

Aesthetic detections for Dardanup bore field

Parameter	**Units**	**ADWG aesthetic guideline value[1]**	**Dardanup bore field**	
			Range	**Mean**
Aluminium (acid soluble)	mg/L	0.2	<0.008–0.075	<0.008
Chloride	mg/L	250	75–190	119.3
Conductivity	mS/m	–	30–43	38
Copper	mg/L	1	0.02–0.09	0.04
Hardness as $CaCO_3$	mg/L	200	24–54	36
Iron unfiltered	mg/L	0.3	<0.003–0.05	<0.003
Manganese unfiltered	mg/L	0.1	<0.002–0.005	<0.002
Silicon as SiO2	mg/L	80	18–22	20.7
Sodium	mg/L	180	41–100	65.4
Sulfate	mg/L	250	7–19	12
Total filterable solids by summation	mg/L	600	173–370	249
Turbidity	NTU	5	<0.1–1	<0.1
pH measured in laboratory	no units	6.5–8.5	***5.36–6.17***	***6.17***
Zinc	mg/L	3	<0.01–0.08	<0.01

[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 Dardanup bore field is analysed for chemicals that are potentially harmful to human health including:

- inorganics
- heavy metals
- industrial hydrocarbons
- pesticides.

Health-related parameters that have been detected in the source are summarised in the following table.

Health-related detections for Dardanup bore field

Parameter	**Units**	**ADWG health guideline value[2]**	**Dardanup bore field**	
			Range	**Mean**
Annual Radiation Dose	mSv	1	0.056–0.113	0.084
Barium	mg/L	2	0.15–0.2	0.169
Boron	mg/L	4	<0.02–0.03	<0.02
Copper	mg/L	2	0.02–0.09	0.04
Chromium	mg/L	0.05	<0.0005–0.0016	<0.0005
Iodide	mg/L	0.5	<0.02–0.03	<0.02
Lead	mg/L	0.01	<0.002–0.006	<0.002
Manganese unfiltered	mg/L	0.5	<0.002–0.005	<0.002
Nickel	mg/L	0.02	<0.002–0.007	<0.002
Nitrate as nitrogen[3]	mg/L	11.29[4]	0.022–0.16	0.05
Nitrite plus nitrate as N[3]	mg/L	11.29[4]	<0.05–0.64	<0.05
Radon-222	Bq/L	100	6.13–28.2	16.271
Sulfate	mg/L	500	7–19	12

[2] 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 & NRMMC 2011).

[3] This is reported as nitrate as nitrogen, whereas the ADWG uses nitrate as nitrate, with a health guideline value of 50 mg/L. This has been converted to 11.29 mg/L so as to compare with the nitrate as nitrogen values that were sampled.

[4] 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 Dardanup 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 may indicate contamination of faecal material.

During the period under review, positive *E. coli* counts were recorded in 3.2 per cent of samples; a total of 4 detections. The detections were all less than 10 MPN/100mL.

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

Land use/activity	Potential water quality risks		Consideration for management	Current preventive measures	Recommended protection strategies
	Hazard	**Management priority**			
Roads, tracks and railway	Hydrocarbons from leaks and accidents	Low	There are existing drainage ditches alongside the roads and railway that may help direct contaminated water out of the water reserve. The roads within the water reserve are sealed bitumen public roads. The railway is not currently being used.	• Water quality monitoring • Emergency response to spills and accidents	• WQPN no. 44: *Roads near sensitive water resources* • WQPN no. 10: *Contaminant spills emergency response* • Incident management procedures in place with Main Roads and the Shire of Dardanup and maintaining emergency response • Public sector circular number 88: *Use of herbicides in water catchment areas*
	Turbidity from erosion and runoff	Very low			
	Pesticides from weed management	Low			
Rural land	Pathogens from septic tanks	Medium	There are only two houses within the water reserve.	• Water quality monitoring	• Community education about protecting the drinking water source

Land use/activity	Potential water quality risks		Consideration for management	Current preventive measures	Recommended protection strategies
	Hazard	**Management priority**			
Rural land	Household chemicals	Low	Onsite wastewater disposal occurs via septic tanks. There are some large lots that are identified for subdivision in the Dardanup Shires local planning. See WQPN no. 25: *Land use compatibility tables for public drinking water source areas* for compatibility of lot sizes for subdivision.		• Encourage regular inspection and maintenance of septic tank systems • Public sector circular number 88 - *Use of herbicides in water catchment areas* • WQPN no. 65: *Toxic and hazardous substances - storage and use*

Land use/activity	Potential water quality risks		Consideration for management	Current preventive measures	Recommended protection strategies
	Hazard	**Management priority**			
Stock grazing (i.e. cattle and horses)	Pathogens from animal waste	Medium	Horses, sheep and other domestic animals are kept on some lots.	• water quality monitoring • Water Corporation surveillance	• Education and the recommendation of best management practices • WQPN no. 80: *Stockyards* • Ensure compliance with stocking rate requirements for horses and other animals • WQPN no. 35: *Pastoral activities within rangelands*
	Nutrients from animal waste	Very low			
Rural land (i.e. flood irrigated pasture and cropping)	Pesticides from weed management	Low	The land is predominately pasture rather than cropping. There is pasture within the water reserve that is flood irrigated for stock grazing.	• water quality monitoring	• Education and the recommendation of best management practices • WQPN no. 1: *Agriculture – dryland crops near sensitive water resources* • WQPN no. 65: *Toxic and hazardous substances - storage and use* • WQPN no. 33: *Nutrient and irrigation management plans*
	Nutrients from fertilisers	Very low			

Land use/activity	Potential water quality risks		Consideration for management	Current preventive measures	Recommended protection strategies
	Hazard	**Management priority**			
Equestrian centre	Pathogens from septic tanks or portable toilets	Medium	Septic tanks are not located close to production bores. Significant numbers of cars, people and horses occurs onsite during events. The paddocks are managed to reduce erosion. Horse manure is not left on paddocks but is collected and stored on hardstands before being removed off-site. Car parking is not located close to the production bores.	• Water quality monitoring • Water Corporation surveillance • Production bores are fenced and located on an raised hardstand	• Education and the recommendation of best management practices • Encourage regular inspection and maintenance of septic tank systems • Portable toilets for events should not be located within the water reserve • Water quality protection guidelines no. 13: *Environmental guidelines for horse facilities and activities* • Water quality awareness brochure: *Managing horses in semi-rural environments* • Ensure compliance with stocking rate requirements for horses and other animals • WQPN no. 35: *Pastoral activities within rangelands*
	Pathogens from horses and cattle waste	High			
	Hydrocarbons from vehicles	Low			
	Turbidity from vehicles and horses	Very low			

Appendix D — Photographs

Photographs by V. Claughton, Department of Water and Environmental Regulation

Figure D1 Dardanup production bore

Figure D2 Dardanup water storage tanks within bore compound

Figure D3 Fencing around production bores and water ponding outside compound

Figure D4 Main road within the water reserve

Figure D5 Dardanup Equestrian Centre within the water reserve

Figure D6 Manure management at the Dardanup Equestrian Centre

Figure D7 Cattle agistment at the Dardanup Equestrian Centre

Figure D8 Rural properties within the Dardanup Water Reserve

Appendix E — 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 the soil. A wide range of microbiological, chemical and physical contamination risks can impact on water quality and therefore affect the provision of reliable, 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 microorganisms that are undetectable by sight, taste or smell (NHMRC & NRMMC 2011). Contaminants can also interfere with water treatment processes and damage infrastructure.

The *Australian drinking water guidelines* (ADWG; NHMRC & NRMMC 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 microorganisms 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, in 2000, seven people died and about 2500 became ill in Walkerton, Canada, because the town's water supply was contaminated by a pathogenic strain of *Escherichia coli* and *Campylobacter* (NHMRC & NRMMC 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 worldwide between 0.6 to 4.3 per cent of people are infected with *Cryptosporidium*, 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, make them 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 & NRMMC 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 & NRMMC 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 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 involves using 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
- 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 (DWER) 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* (DoW 2016a) describes how we do this which is available at 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* (DoW 2016c) 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. Table A1 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 DWER) 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, or read our Strategic policy: *Protecting public drinking water source areas in Western Australia* (DoW 2016a). You can also contact DWER's source protection planning branch on +61 8 6364 7600 or email drinkingwater@dwer.wa.gov.au.

Table A1: 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) which recognise the importance of PDWSAs in protecting 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.

Shortened forms

List of shortened forms

ADWG	*Australian drinking water guidelines*
HAZMAT	hazardous materials
NHMRC	National Health and Medical Research Council
NRMMC	Natural Resource Management Ministerial Council
P1, P2, P3	priority 1, priority 2, priority 3
PSC 88	Public sector circular number 88
PDWSA	public drinking water source area
Westplan–HAZMAT	Western Australian plan for hazardous materials
WHPZ	wellhead protection zone
WQPN	water quality protection note

Units of measurement

Bq/L	becquerels per litre	A measure of radioactivity.
EC	electrical conductivity	This estimates the volume of total dissolved solids or the total volume of dissolved ions in a solution (water) corrected to 25ºC. Measurement units include millisiemens per metre and microsiemens per centimetre.
km	kilometres	A measure of distance, 1 km equals 1000 m.
mSv	millisieverts	Annual radiological dose, with a natural dose equivalent to 2 mSv/y.
mS/m	millisiemens per metre	Electrical conductivity of a solution or soil and water mix that provides a measurement of salinity.
mg/L	milligrams per litre	A measure of concentration of a substance in a solution.
mm	millimetres	A measure of length.

MPN	most probable number	A method used to measure the occurrence of microbes in a sample of water. The procedure uses tubes or microtitre plates and presence/absence tests (WHO 2011).
NTU	nephelometric turbidity units	A measure of turbidity in water.
pH		A logarithmic scale for expressing the acidity or alkalinity of a solution; a pH below 7 indicates an acidic solution and above 7 indicates an alkaline solution.

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 & NRMMC 2011).
Allocation	The volume of water that a licensee is permitted to abstract, usually specified in kilolitres per year (kL/y).
Aquifer	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* (ADWG; NHMRC & NRMMC 2011) outlines acceptable criteria for the quality of drinking water in Australia (see *References*).
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.
Catchment area	An area constituted 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.
Constitute	Define the boundaries of any catchment area or water reserve by Order in Council under the *Country Areas Water Supply Act 1947* or by Proclamation under *the Metropolitan Water Supply, Sewerage and Drainage Act 1909*.
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.

Gazette	Publication within the Government Gazette of Western Australia of the Order in Council or Proclamation defining the boundaries of any catchment area or water reserve.
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 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.
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.
Maximum risk	This is the level of risk in the absence of any preventive measures being installed in the system, or assuming that preventive measures have failed. Assessing maximum risk is useful for identifying high priority risks, determining where attention should be focused and preparing for emergencies (NHRMC & NRMMC 2011).
Nutrients	Minerals, particularly inorganic compounds of nitrogen (nitrate and ammonia) and phosphorous (phosphate) dissolved in water which provide nutrition (food) for plant growth.
Order in Council	Made under the Governor of Executive Council and published in the Government Gazette to constitute or abolish a catchment area or water reserve under section 9 of the *Country Areas Water Supply Act 1947.*
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.

Public drinking water source area	The area from which water is captured to supply drinking water. It includes all underground water pollution control areas, catchment areas and water reserves constituted under the *Metropolitan Water Supply, Sewerage, and Drainage Act 1909* or the *Country Areas Water Supply Act 1947*.
Priority 1, 2 and 3	Three different priority areas are assigned within PDWSAs to guide land use decisions. The objective of priority 1 (P1) areas is *risk avoidance*, priority 1 (P2) areas is *risk minimisation* and priority 3 (P3) areas is *risk management*.
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.
Residual risk	This is the level of risk after considering preventive measures that are applied in the drinking water supply system, such as fencing to keep cattle away from drinking water bores, or surveillance to identify people accessing protected areas. Residual risk provides an indication of how effective preventive strategies are or the need for additional preventive measures (NHRMC & NRMMC 2011).
Runoff	Water that flows over the surface from a catchment area, including streams.
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.
Sole supply	The only source of drinking water for a given town or community. These sources are important to protect as there are no other current options to supply drinking water for that location.
Treatment	Application of techniques such as settlement, filtration and chlorination to render water suitable for specific purposes, including drinking and discharge to the environment.
Turbidity	The cloudiness or haziness of water caused by the presence of fine suspended matter.

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	Collective term for the physical, aesthetic, chemical and biological properties of water.
Water reserve	An area constituted 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.
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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