



Government of Western Australia  
Department of Water

# Gingin Water Reserve

Drinking water source protection review

*Gingin town water supply*



*Looking after all our water needs*

Water resource protection series  
Report WRP 144  
July 2013



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Cover photograph: Aerial photograph of Gingin Water Reserve

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# Preface

## ***How do we protect public drinking water source areas?***

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

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

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

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

Research and experience shows that a combination of catchment protection and water treatment is safer than relying on either barrier on its own. That's why this drinking water source protection plan is important. We should not forget that ultimately it's about protecting your health by protecting water quality now and for the future.

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

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

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

cooperatively with other agencies and the community to implement this legislation and develop drinking water source protection reports.

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

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

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

Stages in development of a plan		Comment
1	Water source protection assessment published by the Water Authority (Report no. WG 203). (1995)	Prepared after initial catchment survey and preliminary information gathering. Information published in <i>Groundwater Protection Plans for the Shires of Dandaragan, Gingin, Moora and Victoria Plains - Goldfields and Agricultural Region</i> , (Holmes 1995).
2	Drinking water source protection plan published by the Water and Rivers Commission (Report no. WRP 2). (1997)	This protection plan was published after considering submissions, further consultation and all information available.
3	Publish drinking water source protection review (Report no. WRP 144). (July 2013)	This review updates and amends the 1997 published plan.  Proclamation of the amended Gingin Water Reserve can be progressed based on the boundary shown in Figure 1 of this review.

## Summary

This drinking water source protection review considers changes and implementation measures that have occurred in and around the Gingin Water Reserve since completion of the *Gingin Water Reserve water source protection plan* (Water and Rivers Commission 1997). Where changes have occurred, this review recommends new management strategies that may be required. This review should be read in conjunction with the *Gingin Water Reserve water source protection plan*, 1997. Both of these documents are available on our website or by contacting us (see details on the inside cover of this report).

Gingin is an agricultural centre located about 84 km north of Perth in the Shire of Gingin. The town has a population of around 743 residents (ABS, 2011).

Water is supplied to the town by the Water Corporation from two production bores, 1/00 and 1/08, which draw water from the Leederville Formation. The Leederville Formation is comprised of both confined and unconfined aquifers in the Gingin area. Due to the depth of the production bores and the nature of the geological formations in the area, the source is considered to be semi-confined. However, further groundwater modelling investigations are required to confirm this.

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

### *Key information about the Gingin Water Reserve*

Local government authority	Shire of Gingin
Locations supplied	Gingin
Aquifer type	Mixture of confined and unconfined
Licensed abstraction	Abstraction for 2011–2012 was 138 772 kL/year. The Water Corporation are licensed to take 410 000 kL/year.
Number of bores	2
Bore name and GPS coordinates	1/00 (E 396 279, N 6 532 094) 1/08 (E 396 280, N 6 532 122)
Date of bore completion	1/00 – 2000 1/08 – 2008 (brought online in 2010)
Date of drinking water source protection reports	1997 – Water source protection plan 2013 – Drinking water source protection review
Proclamation status	Proclaimed on 23 July 1999 under the <i>Country Areas Water Supply Act 1947</i> . Proclamation of an amended boundary (see Figure A1) reflecting the decommissioned bores, will need to be progressed under the <i>Country Areas Water Supply Act 1947</i> when this plan is finalised.



# 1 Review of Gingin's water source protection plan

## 1.1 Boundary, priority areas and protection zones

The Gingin Water Reserve was proclaimed in 1999 under the *Country Areas Water Supply Act 1947*. The water reserve boundary was formed by four 300 m radius, wellhead protection zones (WHPZs) around each of the production bores (1/75, 2/75, 1/84 and 1/85) (see Figure A1). A Priority 3 (P3) area was assigned to the Gingin Water Reserve for the protection of water quality (see Figure A2).

The four production bores that were active in 1997 when the plan was published have since been decommissioned. There are now two new production bores—1/00 and 1/00—located near the decommissioned bores 1/75 and 2/75, in the same area of the Edgar Street wellfield. This means that the previous WHPZs should now be removed and the Gingin Water Reserve boundary should be amended with a WHPZ to reflect the new bores.

The majority of the amended Gingin Water Reserve should remain as P3. However, the production bore compound owned by the Water Corporation will be assigned as a Priority 1 (P1) area. These priority areas are consistent with the Shire of Gingin's *Local planning scheme no. 9*, existing zoning and land uses. Please refer to Figure A2 for the priority areas within the Gingin Water Reserve.

The proposed boundary reflects our current understanding that risks to the water source are reduced because the production bores are drawing water from a semi-confined aquifer. To confirm this understanding, groundwater modelling for the Gingin production bores to validate the water reserve boundary should be undertaken in future groundwater studies.

The decisions about the boundary, priority areas and protection zones as described above, have been determined in accordance with current departmental policy.

If you require more information on the background to and support for protection of public drinking water source areas (PDWSAs), please refer to our Water quality protection note (WQPN) no. 36: *Protecting public drinking water source areas*.

## 1.2 Update on water supply scheme

The water supply for Gingin is sourced from a bore field located at Edgar Street, approximately 1 km from the town centre. The bore field is comprised of two production bores; 1/00 and 1/08. These bores are drilled to around 150 m deep and draw water from the lower Leederville Formation. Production bore 1/00 is screened between 114 m and 147 m and production bore 1/08 is screened from 135 m to 147 m. Please see Figure A1 for the location of the current production bores in the Gingin Water Reserve. Production bores 1/00 and 1/08 have replaced the

decommissioned production bores 1/75 and 2/75 described in the 1997 water source protection plan.

The previous water source protection plan also included information on the decommissioned production bores 1/84 and 1/85, which are located closer to the town centre on Daw Street. These bores were previously used for stand-by supply, but as they are no longer required they have been decommissioned.

Groundwater from the production bores is transported to treatment facilities located on-site within the same fenced compound as the bores. Raw water treatment comprises of soda ash injection prior to aeration for pH correction. Chlorine dosing occurs during the aeration process and is followed by filtration and settlement. The aeration and filtration reduce high iron levels in the water. Settlement takes place in the first of two 225 kL reinforced concrete tanks. Then a pump station transfers treated water to a 2250 kL storage tank situated at Mole Hill, where it is distributed to the reticulation system.

The Water Corporation's groundwater allocation licence has recently been renewed. The licence allows the Water Corporation to draw 410 000 kL/year of water from the lower Leederville Formation to supply Gingin's drinking water. This licence expires in 2020.

The Gingin scheme has experienced a gradual increase in growth and this trend is expected to continue as the town of Gingin continues to expand. The current groundwater source should be capable of meeting projected demand.

It should be recognised that although treatment and disinfection are essential barriers against contamination, 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 & NRMCC 2011) and reflects a preventive risk-based, multiple-barrier approach for providing safe drinking water to consumers. The 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 the preface at the front of this plan.

### 1.3 Aboriginal native title claims

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 Gingin Water Reserve. This is the Single Noongar Claim, Area 1 (WAD6006/03).

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

## 1.4 Update on water quality risks

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

As Gingin's drinking water is drawn from a semi-confined groundwater source, there is little potential for contamination. This is because there is a semi-confining layer sitting above the groundwater resource, acting as a barrier to contamination. Table 1 shows an assessment of the risks to water quality in the Gingin Water Reserve.

Recharge to the aquifer occurs by direct infiltration over the Gingin town site and further east where the Leederville Formation is recharged near the Darling Scarp. Groundwater in the area of the bore field flows westerly towards the Indian Ocean.

The Gingin town centre is located approximately 1 km from the bores. Two-thirds of the land surrounding the bores is zoned residential and the remaining area is rural.

There are several undeveloped lots to the north and south-west of the bores, but the remaining land in the southern area of the water reserve is already developed as residential land.

Agricultural land uses occur on the north side of the new WHPZ (see figures A2 and A3). Some of this agricultural land is zoned residential in the Shire of Gingin's, *Local planning scheme no.9*, so it could potentially be developed into residential lots in the future.

The production bores are in a secure compound that is owned by the Water Corporation. There have been no reported problems of vandalism of the production bore compound. The Water Corporation conducts regular inspections of the bore compound.

There are no licensed bores within the Gingin Water Reserve, however there are up to four licensed bores within 1 km of the production bores.

Bores drilled near a public drinking water supply bore (e.g. for irrigation or private purposes) can cause contamination of the drinking water source. For example, a poorly constructed bore may introduce contaminants from surface leakage down the outside of the bore casing into an otherwise uncontaminated aquifer.

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

The town of Gingin is unsewered, but there is minimal risk of pathogen and nutrient contamination from septic tanks due to the significant depth and semi-confined nature of the aquifer. This is also the case for other risks such as the application of agricultural nutrients and chemicals in the area.

In addition to the significant depth and construction of the bores, the interbedded nature of the Leederville Formation in the area also reduces the risk of contamination to the production bores by inhibiting leaching.

The production bores are sealed and located at the highest elevation of the area. This reduces the risk of contamination of the bores from contaminated surface water run-off (e.g. water contaminated with manure), because it will flow away from the production bores.

There are a number of management strategies that have been implemented to minimise the risk to this drinking water source. The Water Corporation undertakes routine surveillance of the Gingin Water Reserve and liaises with surrounding landowners when required. The fencing around the production bores, sealing around the bores and signs around the bore compounds are all maintained regularly. The Water Corporation also undertakes raw water sampling for contamination to ensure the water quality of this water source is adequate.

**Table 1** Summary of potential water quality risks, land use compatibility and best management practices

Land use/activity	Hazard	Management priority	Comments	Best management practice guidance <sup>1</sup>
Residential	Pathogens, nutrients, chemicals and hydrocarbons	Low	These developed areas are close to the production bores, however the aquifer is semi-confined which reduces water quality risks.	WQPN no. 70: <i>Wastewater treatment and disposal : domestic systems;</i> WQPN no. 54: <i>Rezoning and subdivision of land in public drinking water source areas</i>
Agriculture	Nutrients, chemicals and pathogens	Low		WQPN no. 1: <i>Agriculture : dryland crops near sensitive water resources;</i> Public sector circular number 88
Roads and tracks	Hydrocarbons	Low	Traffic levels are low within the water reserve.	WQPN no. 44: <i>Roads near sensitive water resources</i>
Other bores	Potentially pathogens, nutrients, hydrocarbons and chemicals	Low	New bores require a licence from the Department of Water if they are to be drilled into the confined aquifer or if they are for anything other than domestic purposes.	<i>Minimum construction requirements for water bores in Australia</i> (National Uniform Drillers Licensing Committee 2012).

<sup>1</sup>Water quality protection notes are available <<http://drinkingwater.water.wa.gov.au>> and scroll down to the link for *water quality protection notes*.

## 1.5 Water quality information

The Water Corporation have provided water quality information for the Gingin production bores. This is shown in Appendix B.

Raw water from the Edgar Street production bores has consistently been of good quality, and with the exception of pH, iron and turbidity, has generally met the guidelines for drinking water quality in Australia.

Low pH, high iron and turbidity levels are naturally occurring and typical of groundwater within the Gingin area of the Leederville Formation. These aspects of the water are treated before supply to consumers.

## 2 Implementation of Gingin's drinking water source protection plan

### 2.1 Status of previous recommendations

Table 2 outlines recommendations from the 1997 plan and their current status.

*Table 2 Implementation status for Gingin Water Reserve*

No.	Recommendation	Status	Comments
1	Gazettal of water reserve.	Implemented	Gazetted in 1999 under the <i>Country Areas Water Supply Act 1947</i> .
2	Incorporation into land planning strategies.	Implemented	The Gingin Water Reserve has been incorporated in Gingin's <i>Local planning scheme no.9</i> .
3	Referral of development proposals: <ul style="list-style-type: none"> <li>Department of Water (formerly Water and Rivers Commission) to provide the Shire of Gingin with guidelines for referral of development proposals.</li> <li>Referral of development proposals.</li> </ul>	Implemented	Guidelines have been provided through the water quality protection note series.  Development proposals within all PDWSAs are referred to the Swan Avon Regional office of the Department of Water.
4	Erection of signs: <ul style="list-style-type: none"> <li>Erect signs along the boundary of the water reserve.</li> </ul>	Progressed	Signs advising of the entrance to the production bore compound and on the compound are in place but additional signs along the boundary of the water reserve are required.
5	Emergency response: <ul style="list-style-type: none"> <li>Develop process to address any spillage of pollutants within the water reserve.</li> </ul>	Implemented	It has been determined that due to the semi-confined nature of this source, this recommendation is not required and emergency response matters are no different to other locations in Gingin.
6	Surveillance program put in place to identify incompatible land uses or potential contaminant threats within the water reserve.	Implemented	Water Corporation undertakes surveillance within the water reserve.
7	Review of the plan and recommendations.	Implemented	Undertaken through the preparation of this review document.

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 five 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 table below shows the differences between the types of reports.

*Table 3 Drinking water source protection reports*

<b>Drinking water source protection report</b>	<b>Scope and outcome</b>	<b>Consultation</b>	<b>Time to prepare</b>	<b>Implementation table</b>	<b>Proclamation</b>
Drinking water source protection assessment (DWSPA)	Desktop assessment of readily available information	Targeted	3 – 6 months	Yes, if there has been a previous drinking water source protection plan	Yes, proclamation to protect water quality and guide land use planning can occur as a result of any type of drinking water source protection report
Drinking water source protection plan (DWSP)	Full investigation of risks to water quality building on information in the DWSPA	Key stakeholders, public with advertising	6 – 12 months	Prepared from recommendations in the DWSPA and information from public consultation	
Drinking water source protection review (DWSPR)	Review changes in land and water factors and implementation of previous recommendations	Key stakeholders	Up to 3 months	Prepared from recommendations in the DWSPA or DWSP	

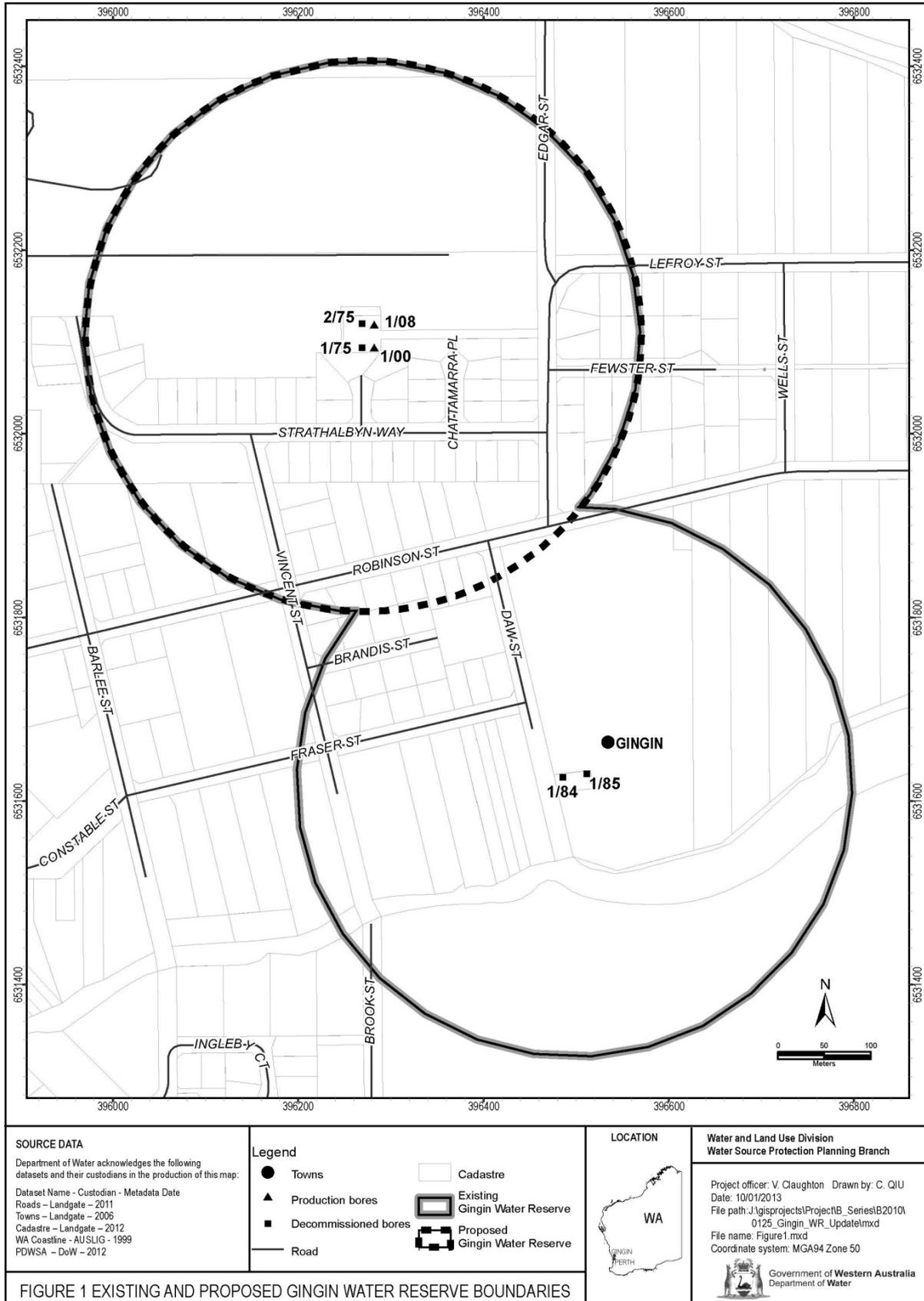
## 2.2 Consolidated recommendations

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

1. Amend the boundary of the Gingin Water Reserve under the *Country Areas Water Supply Act 1947*. (Department of Water)
2. Incorporate the findings of this plan and location of the Gingin Water Reserve in the Shire of Gingin'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 Gingin)
3. Erect signs along the boundary of the Gingin Water Reserve including an emergency contact telephone number. (Water Corporation)
4. Update the drinking water source protection report after five years. This may require a new plan if substantial changes have occurred. If not, a drinking water source protection review may be developed. (Department of Water)
5. Conduct a groundwater assessment to improve the accuracy of the Gingin Water Reserve boundary. Include updated boundary into the next five-yearly review, or sooner if required. (Department of Water)

# Appendices

## Appendix A – Figures



**SOURCE DATA**  
 Department of Water acknowledges the following datasets and their custodians in the production of this map:  
 Dataset Name - Custodian - Metadata Date  
 Roads - Landgate - 2011  
 Towns - Landgate - 2006  
 Cadastre - Landgate - 2012  
 WA Coastline - AUSLIG - 1999  
 PDWSA - DoW - 2012

**Legend**

- Towns
- ▲ Production bores
- Decommissioned bores
- Road
- Cadastral
- ▭ Existing Gingin Water Reserve
- ▭ Proposed Gingin Water Reserve

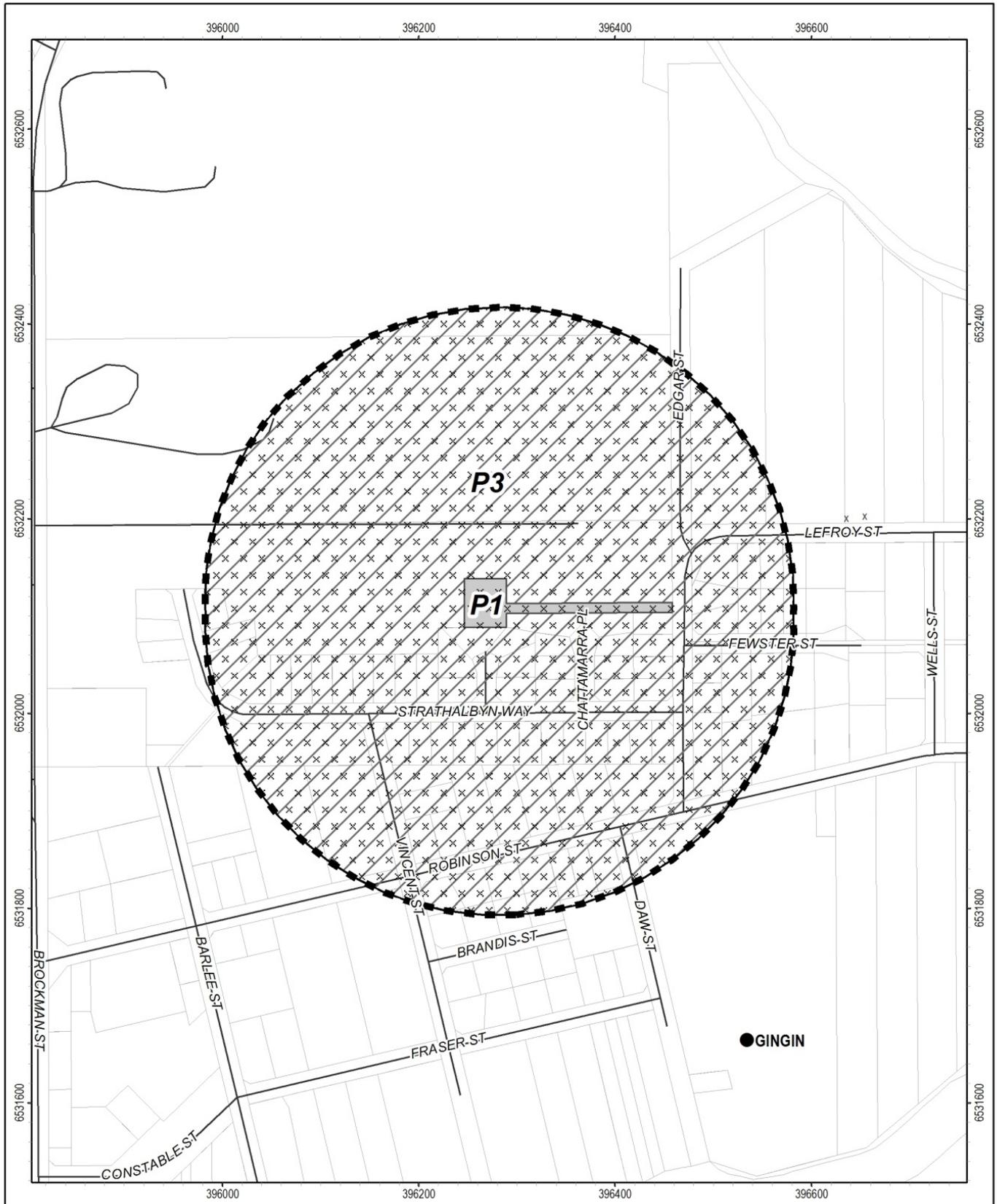


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**Water Source Protection Planning Branch**

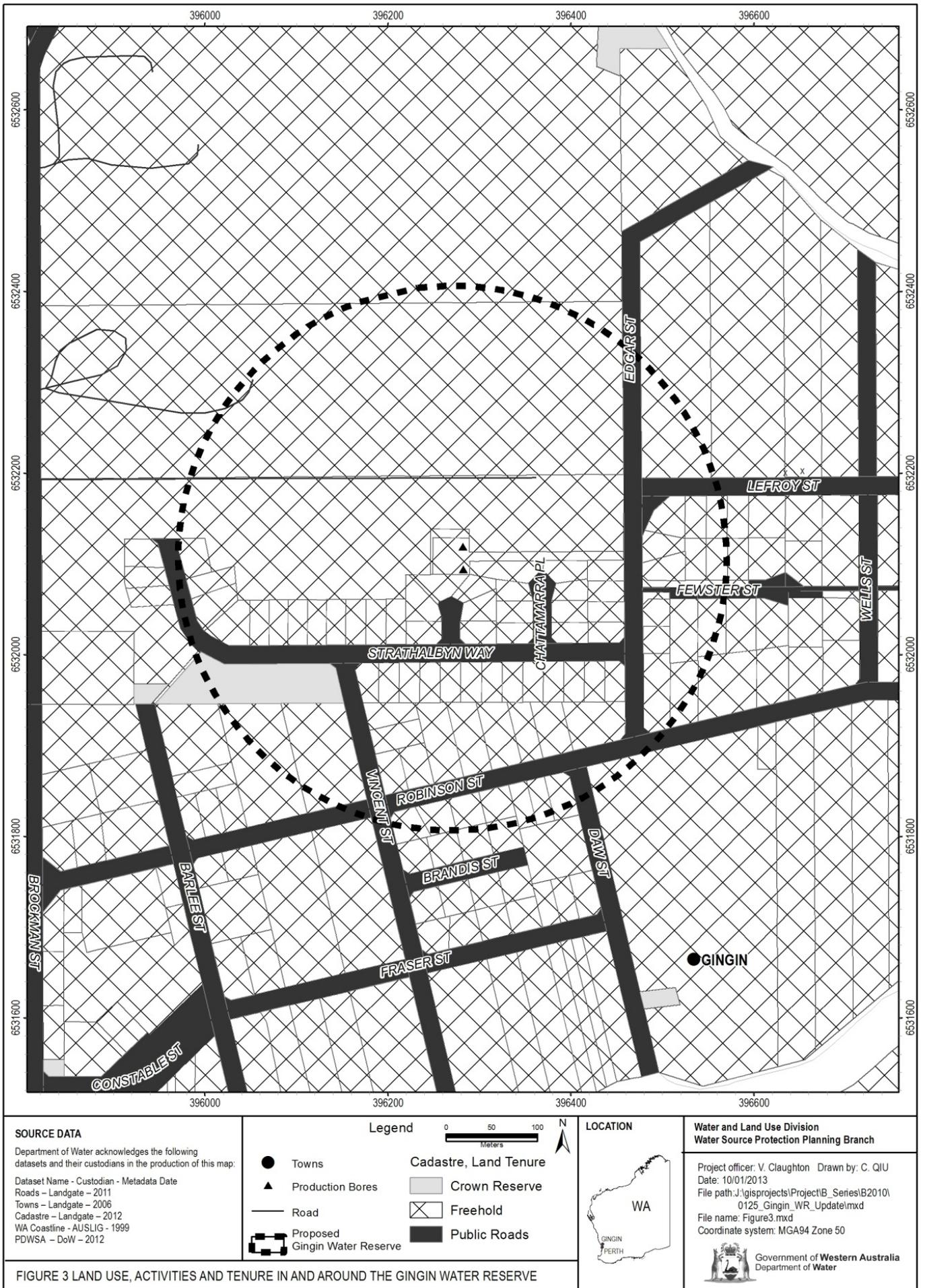
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 Date: 10/01/2013  
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 File name: Figure1.mxd  
 Coordinate system: MGA94 Zone 50

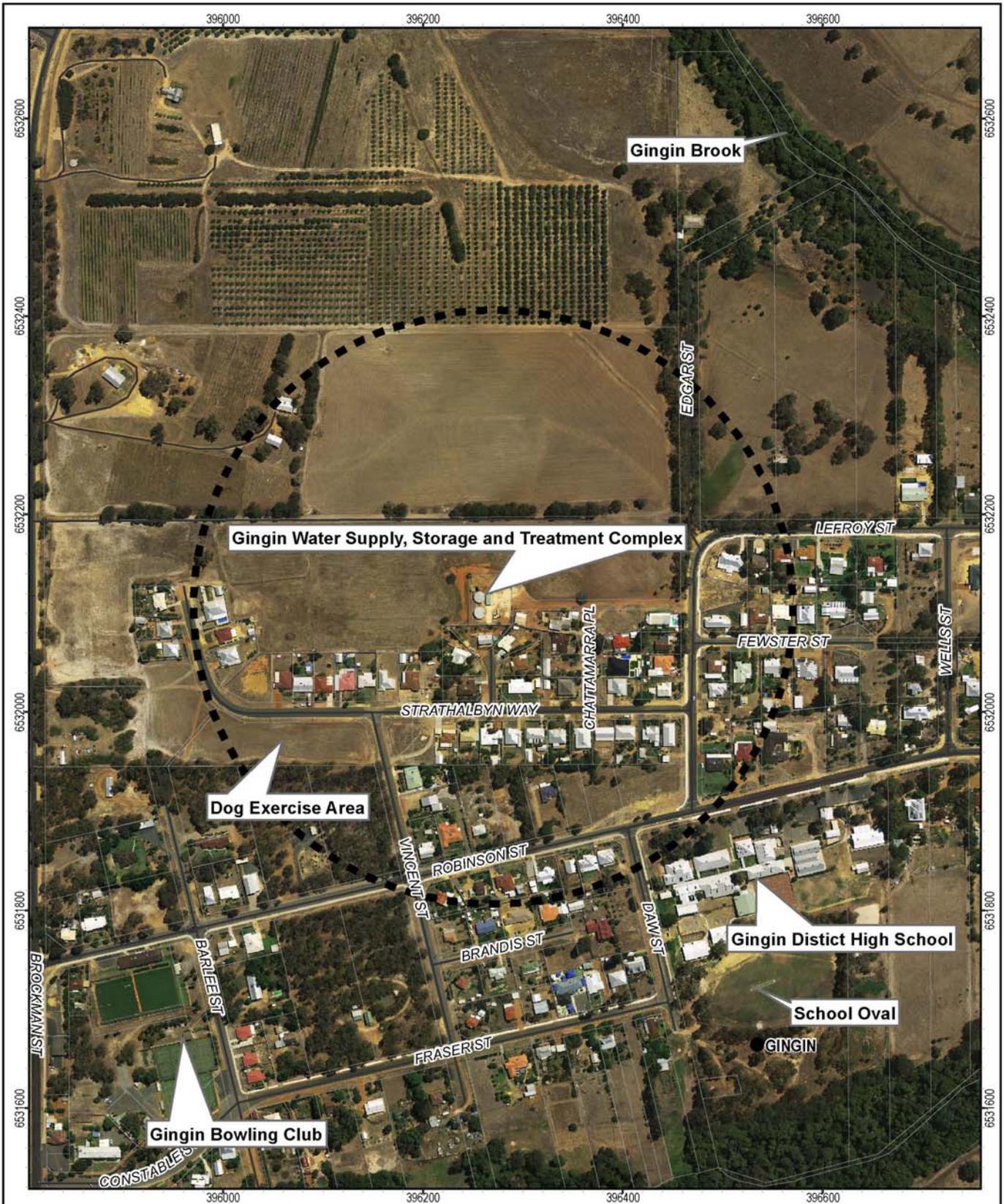
Government of Western Australia  
 Department of Water

**FIGURE 1 EXISTING AND PROPOSED GINGIN WATER RESERVE BOUNDARIES**



<p><b>SOURCE DATA</b></p> <p>Department of Water acknowledges the following datasets and their custodians in the production of this map:</p> <p>Dataset Name - Custodian - Metadata Date                  Roads - Landgate - 2011                  Towns - Landgate - 2006                  Cadastre - Landgate - 2012                  WA Coastline - AUSLIG - 1999                  PDWSA - DoW - 2012</p>	<p><b>Legend</b></p> <ul style="list-style-type: none"> <li> Cadastre</li> <li> Proposed Gingin Water Reserve</li> <li> Proposed Gingin Wellhead Protection Zone - 300m</li> <li> N</li> <li> 0 50 100 Meters</li> <li> Towns</li> <li> Road</li> <li> Priority 1</li> <li> Priority 3</li> </ul>	<p><b>LOCATION</b></p>	<p><b>Water and Land Use Division</b>                  Water Source Protection Planning Branch</p> <p>Project officer: V. Cloughton Drawn by: C. QIU                  Date: 10/01/2013                  File path: J:\gis\projects\ProjectB_Series\B2010\0125_Gingin_WR_Update\mxd                  File name: Figure2.mxd                  Coordinate system: MGA 94 Zone 50</p>
<p><b>FIGURE 2 PROPOSED BOUNDARY, PRIORITY AREAS AND WELLHEAD PROTECTION ZONE OF THE GINGIN WATER RESERVE</b></p>			





<p><b>SOURCE DATA</b></p> <p>Department of Water acknowledges the following datasets and their custodians in the production of this map:</p> <p>Dataset Name - Custodian - Metadata Date                  Roads - Landgate - 2011                  Towns - Landgate - 2006                  Cadastre - Landgate - 2012                  WA Coastline - AUSLIG - 1999                  PDWSA - DoW - 2012</p>	<p><b>Legend</b></p> <ul style="list-style-type: none"> <li>● Towns</li> <li>— Road</li> <li>▬ Proposed Gingin Water Reserve</li> </ul> <div style="text-align: center;"> <p>N</p> <p>0 50 100 Meters</p> </div>	<p><b>LOCATION</b></p>	<p>Water and Land Use Division                  Water Source Protection Planning Branch</p> <p>Project officer: V. Claughton Drawn by: C. QIU                  Date: 10/01/2013                  File path: J:\gisprojects\Project\B_Series\B2010\0125_Gingin_WR_Update.mxd                  File name: Figure4.mxd                  Coordinate system: MGA94 Zone 50</p>
<p>FIGURE 4 AERIAL PHOTOGRAPHY AND LAND USES IN AND AROUND THE GINGIN WATER RESERVE</p>			

## 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 Gingin in accordance with the requirements of the *Australian drinking water guidelines* (ADWG) (NHMRC & NRMCC 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 Gingin (Edgar Street 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 July 2007 to June 2012.

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

For more information on the quality of drinking water supplied to the mid-west region, refer to the most recent Water Corporation drinking water quality annual report at <[www.watercorporation.com.au](http://www.watercorporation.com.au)> What we do > Water quality > Water quality publications > most recent *Water quality annual report*.

### *Aesthetic characteristics*

The aesthetic water quality analyses for raw water from Gingin (Edgar Street Bore field) are summarised in the following table.

#### *Aesthetic detections for Gingin (Edgar Street bore field)*

Parameter	Units	ADWG aesthetic guideline value*	Gingin Edgar Street bore field raw source	
			Range	Median
Chloride	mg/L	250	85–130	100
Colour (true)	TCU	15	<1–2	<1
Hardness as CaCO <sub>3</sub>	mg/L	200	20–40	29
Iron unfiltered	mg/L	0.3	<b>1.2–3</b>	<b>2</b>
Manganese unfiltered	mg/L	0.1	0.025–0.06	0.044
Sodium	mg/L	180	45–64	52
Sulfate	mg/L	250	10–12	11
Total filterable solids by summation	mg/L	600	191–280	221
Turbidity	NTU	5	<b>1–26</b>	<b>11</b>
pH measured in laboratory	no units	6.5–8.5	<b>5.44–6.13</b>	<b>5.66</b>

\* 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 Gingin (Edgar Street bore field) is analysed for chemicals that are harmful to human health, including inorganics, heavy metals, industrial hydrocarbons and pesticides. Health-related parameters that have been detected in the source are summarised in the following table.

#### Health-related detections for Gingin (Edgar Street bore field)

Parameter	Units	ADWG health guideline value*	Gingin Edgar Street bore field raw source	
			Range	Median
Barium	mg/L	0.7	0.19–0.25	0.215
Boron	mg/L	4	<0.02–0.02	<0.02
Iodide	mg/L	0.1	0.04	0.04
Manganese unfiltered	mg/L	0.5	0.025–0.06	0.044
Nitrite as nitrogen	mg/L	0.91	<0.002–0.006	<0.002
Nitrite plus nitrate as N	mg/L	11.29	<0.002–0.012	<0.05
Sulfate	mg/L	500	10–12	11

\* 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 Gingin (Edgar Street 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 not recorded in any samples.

## Appendix C – Photographs



*Figure D1 Agricultural land uses within the Gingin Water Reserve and fencing surrounding Edgar Street bores and water treatment compound, photograph by V. Cloughton*



*Figure D2 Residential land use within the Gingin Water Reserve, photograph by V. Cloughton*

## List of shortened forms

<b>ADWG</b>	<i>Australian drinking water guidelines</i>
<b>ANZECC</b>	Australian and New Zealand Environment Conservation Council
<b>ARMCANZ</b>	Agriculture and Resource Management Council of Australia and New Zealand
<b>HAZMAT</b>	hazardous materials
<b>kL</b>	kilolitre
<b>m</b>	metres
<b>mg/L</b>	milligram per litre
<b>NHMRC</b>	National Health and Medical Research Council
<b>NRMMC</b>	Natural Resource Management Ministerial Council
<b>P1</b>	Priority 1
<b>P2</b>	Priority 2
<b>P3</b>	Priority 3
<b>PDWSA</b>	public drinking water source area
<b>TCU</b>	true colour units
<b>WESTPLAN- HAZMAT</b>	Western Australian plan for hazardous materials
<b>WHPZ</b>	wellhead protection zone
<b>WQPN</b>	water quality protection note

# Glossary

<b>Abstraction</b>	The pumping of groundwater from an aquifer, or the removal of water from a waterway or water body.
<b>Aesthetic guideline value</b>	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).
<b>Allocation</b>	The quantity of water that a licensee is permitted to abstract is their allocation, usually specified in kilolitres per annum (kL/a).
<b>Aquifer</b>	An aquifer is a geological formation or group of formations able to receive, store and transmit significant quantities of water.
<b>Australian drinking water guidelines</b>	The <i>National water quality management strategy: Australian drinking water guidelines 6, 2011</i> (NHMRC & NRMMC 2011) (ADWG) outlines acceptable criteria for the quality of drinking water in Australia (see this plan's Bibliography).
<b>Bore</b>	A bore is a narrow, lined hold drilled into the ground to monitor or draw groundwater (also called a well).
<b>Bore field</b>	A group of bores to monitor or withdraw groundwater is referred to as a bore field (also see <i>wellfield</i> ).
<b>Catchment</b>	The physical area of land which intercepts rainfall and contributes the collected water to surface water (streams, rivers, wetlands) or groundwater.
<b>Drinking water source protection plan</b>	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.
<b>Health guideline value</b>	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).
<b>Hydrocarbons</b>	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.
<b>Interbedded</b>	Layers between, or alternating with, other layers of differing geological character.

<b>kL</b>	A kilolitre is a term commonly used to measure water, equal to 1000 litres. A cubic metre is the volume occupied by a cube measuring one metre along each edge. One cubic metre contains one kilolitre of water which weighs approximately one tonne.
<b>Leaching/leachate</b>	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.
<b>mg/L</b>	A milligram per litre (0.001 grams per litre) is a measurement of a total dissolved solid in a solution.
<b>Nutrients</b>	Minerals, particularly inorganic compounds of nitrogen (nitrate and ammonia) and phosphorous (phosphate) dissolved in water which provide nutrition (food) for plant growth.
<b>Pathogen</b>	A disease-producing organism that can cause sickness and sometimes death through the consumption of water, including bacteria (such as <i>Escherichia coli</i> ), protozoa (such as <i>Cryptosporidium</i> and <i>Giardia</i> ) and viruses.
<b>Pesticides</b>	Collective name for a variety of insecticides, fungicides, herbicides, algicides, fumigants and rodenticides used to kill organisms.
<b>pH</b>	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.
<b>Public drinking water source area</b>	Includes all underground water pollution control areas, catchment areas and water reserves constituted under the <i>Metropolitan Water Supply Sewerage and Drainage Act 1909</i> and the <i>Country Areas Water Supply Act 1947</i> .
<b>Recharge</b>	Recharge is the action of water infiltrating through the soil/ground to replenish an aquifer.
<b>Semi-confined aquifer</b>	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.
<b>Treatment</b>	Application of techniques such as settlement, filtration and chlorination to render water suitable for specific purposes, including drinking and discharge to the environment.
<b>True colour units</b>	True colour units are a measure of degree of colour in water.

<b>Turbidity</b>	The cloudiness or haziness of water caused by the presence of fine suspended matter.
<b>Wastewater</b>	Water that has been used for some purpose and would normally be treated and discarded. Wastewater usually contains significant quantities of pollutant.
<b>Water quality</b>	Water quality is the collective term for the physical, aesthetic, chemical and biological properties of water.
<b>Water reserve</b>	A water reserve is an area proclaimed under the <i>Country Areas Water Supply Act 1947</i> or the <i>Metropolitan Water Supply, Sewerage and Drainage Act 1909</i> for the purposes of protecting a drinking water supply.
<b>Wellfield</b>	A wellfield is a group of bores located in the same area used to monitor or withdraw groundwater.
<b>Wellhead</b>	The top of a well (or bore) used to draw groundwater is referred to as a wellhead.
<b>Wellhead protection zone</b>	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.
<b>Western Australian hazardous materials emergency management scheme</b>	This is now known as Westplan–HAZMAT.

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