



Government of Western Australia  
Department of Water

# Moora Water Reserve

Drinking water source protection review

*Moora town water supply*



*Looking after all our water needs*

Water resource protection series  
Report WRP 142  
October 2013



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Cover photograph: Aerial photograph showing the proposed Moora Water Reserve

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## Summary

This drinking water source protection review considers information that has become available since the *Moora Water Reserve water source protection plan* was completed (Water and Rivers Commission 1999). This review should be read in conjunction with the 1999 plan. Both of these documents are available on our website or by contacting us (see details on the inside cover of this report).

Moora is located in the Wheatbelt at the foot of the Darling Scarp about 175 km north of Perth (see Figure 1). It is a thriving town, nestled amongst a diverse range of economic opportunities including horticultural and livestock developments. Moora is the largest inland service centre between Perth and Geraldton, providing services to a population of 6000 residents within a 100 km radius (Shire of Moora 2013). Moora services the local agricultural and small-scale mining and quarry industries. It is also the administrative centre for the Shire of Moora. In 2011 the population of Moora was 1822 (Australian Bureau of Statistics 2012).

When the *Moora Water Reserve water source protection plan* was published in 1999, Moora received its water supply from two sources; the Moora Eastern Water Reserve bore field, located approximately 1.5 km east of the townsite in the Shire of Moora, and the Kolburn (western) bore field, located approximately 13 km west of the townsite in the Shire of Dandaragan (see Figure 2). Since then, the water supply system has changed. The Moora Eastern Water Reserve bore field is now used for agricultural and quarrying activities, instead of for drinking water.

Moora now receives its drinking water from two production bores in the Kolburn bore field. These bores are located in a secure compound owned by the Water Corporation, and draw water from a confined groundwater aquifer, which has a low risk of contamination. This water source is strategically important because it is the sole public drinking water supply for Moora. We will assign a Priority 1 (P1) area to this reserve to reflect its importance.

This review recommends:

- abolishing (deproclaiming) the Moora Eastern Water Reserve as it is no longer used as a drinking water source. This will remove existing land-use planning constraints that were previously applied to protect drinking water quality.
- proclaiming the proposed Moora Water Reserve under the *Country Areas Water Supply Act 1947* to ensure that the water supply bores can be considered in future development proposals that have the potential to contaminate this confined aquifer.

This review has been prepared in consultation with key stakeholders, including the Water Corporation and the shires of Moora and Dandaragan.

Table 1 shows important information about the proposed Moora Water Reserve.

Table 1 Key information about the proposed Moora Water Reserve

Local government	Shire of Dandaragan
Locations supplied	Moora
Aquifer type	Confined
Groundwater area	Jurien
Groundwater subarea	Dinner Hill
Bore field area	Kolburn
Licensed abstraction	650 000 kL/year
Production bores	1/82 1/89
Bore locations	1/82 – Lot 4057 on diagram 49612 1/89 – Lot 2395 on plan 89781
GPS coordinates in m MGA94 (GDA)	1/82 – Easting 392 630, Northing 6 612 737, Zone 50 1/89 – Easting 392 690, Northing 6 612 801, Zone 50
Casing depth	1/82 – 311 m below top of casing 1/89 – 343 m below top of casing
Date bore drilled	1/82 – 25 November 1982 1/89 – 31 May 1989
Bore commissioned	1/82 – 1983 1/89 – 1990
Proclamation status	Abolition of the existing Moora Eastern Water Reserve will be progressed after this review is published.  Proclamation of the proposed Moora Water Reserve will be progressed under the <i>Country Areas Water Supply Act 1947</i> after this review is published.



<p>Stages involved in the preparation of this drinking water source protection report</p>	<p>1999 – <i>Moora Water Reserve water source protection plan</i></p> <p>2013 – Advice sought from the Water Corporation and the shires of Moora and Dandaragan regarding changes to the Moora water source since 1999.</p> <p>2013 – <i>Moora Water Reserve drinking water source protection review</i> (this document) prepared to reflect changes to this water source since publication of the 1999 plan.</p>
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# 1 Review of Moora's 1999 drinking water source protection plan

## 1.1 Boundary, priority areas and protection zones

When the *Moora Water Reserve water source protection plan* (Water and Rivers Commission 1999) was published, Moora received its water supply from two sources: the Moora Eastern Water Reserve, located approximately 1.5 km east of the townsite, and the Kolburn (western) bore field, located approximately 13 km west of the townsite. At that time, the main water supply for Moora came from the Kolburn bore field and the Moora Eastern Water Reserve was only used intermittently to meet peak demand during summer.

Water from the Moora Eastern Water Reserve was drawn from a shallow, fractured rock aquifer which made it vulnerable to contamination. This reserve was assigned a Priority 2 (P2) area due to its zoning in the local planning scheme. The reserve also included wellhead protection zones. However, this bore field is no longer used as a drinking water supply. It now supplies water for agriculture and quarries.

Unlike the Moora Eastern Water Reserve, the Kolburn bore field obtains groundwater from the Lower Leederville Formation. This bore field was not previously proclaimed because its water is drawn from a confined aquifer and therefore has a low risk of contamination from land uses on the surface.

Since the publication of the *Moora Water Reserve water source protection plan* in 1999, the Department of Water's policy on protecting drinking water sources has changed. Confined aquifer sources of drinking water, such as Moora, are now also proclaimed. This proclamation ensures that this important water supply can be identified, mapped and considered in future development proposals that have the potential to contaminate the confined aquifer.

Figure 3 shows the proposed Moora Water Reserve boundary. A larger boundary is not necessary because this source is adequately protected from surface contamination risks by a confining layer of rock. The Department of Water will arrange proclamation of the proposed Moora Water Reserve under the *Country Areas Water Supply Act 1947*. At the same time, we will assign a Priority 1 (P1) area to the water reserve. This P1 area is supported by the Water Corporation.

The Department of Water will abolish the Moora Eastern Water Reserve as it is no longer required as a drinking water source.

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 no. 36: *Protecting public drinking water source areas* or contact us (details on the inside cover page).

## 1.2 Current water supply scheme

The drinking water supply for Moora is obtained from two production bores, 1/82 and 1/89, in the proposed Moora Water Reserve (see Figure 2). These bores draw water from the confined aquifer in the Lower Leederville Formation. Bore 1/82 is located on freehold Lot 4057 and bore 1/89 is located on freehold Lot 2395. Both of these lots are owned by the Water Corporation and are surrounded by privately owned arable land.

Production bore 1/82 is screened from 292 m to 311 m below ground level and bore 1/89 is screened from 297 m to 342 m below ground level.

Groundwater drawn by these production bores is treated on-site. It undergoes aeration, filtration and chemical dosing to remove iron and manganese. It is dosed with sodium carbonate (soda ash) for pH correction. Chlorination is carried out to disinfect the water, to ensure microbiological quality for consumers before being pumped into storage tanks.

The Water Corporation's current groundwater allocation licence GWL70241(3) was issued in 2010 under the *Rights in Water and Irrigation Act 1914*. This licence allows the Water Corporation to draw 650 000 kL of water per year from the Leederville aquifer (confined) to supply Moora's drinking water. This licence expires on 31 December 2013. The Water Corporation will need to apply to this department to have the groundwater allocation licence renewed.

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

## 1.3 Update on water quality risks

As part of this review, we have conducted an assessment of current water quality contamination risks to the Moora drinking water source.

As Moora's drinking water is drawn from a confined groundwater source there is little potential for contamination from surrounding land uses. This is because the source is adequately protected from surface contamination by the considerable depth to the groundwater and the presence of a confining multi-layered rock structure that sits above the groundwater. This confining layer acts as a barrier to contamination.

However, bores drilled near a public drinking water supply bore (e.g. for irrigation or resource development 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 constructed in the future are appropriately located and constructed to prevent contamination of this public drinking water source. This will be assessed where applicable through the Department of Water's water licensing process under the *Rights in Water and Irrigation Act 1914*. All bores should be constructed in accordance with *Minimum construction requirements for water bores in Australia* (National Minimum Bore Specifications Committee 2012).

At this time, there is only one other licensed user nearby with a bore in the superficial, shallow aquifer (not the confined aquifer).

There are a number of management strategies that have been implemented to minimise the risk to this drinking water source. The two public drinking water supply bores are in a secure compound that is owned and managed by the Water Corporation. Sealing around the production bores, fencing and signs around the bore compounds are all maintained regularly.

During a site visit on 22 May 2013 by the Department of Water and the Water Corporation one bore (1/89) appeared to have gaps in the bore seal. The Water Corporation has advised that they will ensure this bore is properly sealed.

The Water Corporation conducts regular inspections of the bore compound. There have been no reported problems with the security or vandalism of the production bore compound. In addition, the Water Corporation undertakes regular water quality testing of this water source (refer to section 1.4).

## 1.4 Water quality information

The Water Corporation has provided updated water quality monitoring information for the proposed Moora Water Reserve for the period July 2007 to June 2012. This monitoring data is shown in Appendix B.

Raw water from the bore field has been consistently of good quality, and with the exception of pH, iron, manganese and turbidity has generally met the ADWG requirements. Analyses show the groundwater is naturally acidic. The presence of high levels of iron and manganese in the water is naturally occurring and is a characteristic of the source.

Groundwater salinity in this bore field has remained stable between 400 and 600 mg/L total dissolved solids (TDS) since 1987.

The raw water undergoes treatment (see section 1.2) to ensure it meets the requirements of the ADWG before it is supplied to consumers.

## 2 Implementation of drinking water source protection plans

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 to seven years. In some locations, more frequent updates may be required to address changing water quality risks and land uses. These updates allow us to make changes to the PDWSA boundary, priority areas and protection zones if required. They also allow solutions to new water quality risks to be considered.

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

*Table 2 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>
Drinking water source protection assessment (DWSPA)	Desktop assessment of land uses/zoning and risks to water quality.	Targeted	Up to 3 months
Drinking water source protection plan (DWSPP)	Full investigation of risks to water quality building on information in the DWSPA.	Public, with advertising	6–12 months
Drinking water source protection review (DWSPR)	Review changes in land and water factors and implementation of previous recommendations.	Key stakeholders	Up to 3 months

## 2.1 Implementation of Moora's drinking water source protection plan

### 2.1.1 Status of previous recommendations

There is no recommendation in the *Moora Water Reserve water source protection plan* (1999) that applies to the Kolburn (western) bore field.

The implementation of recommendations in the 1999 plan that apply to the Moora Eastern Water Reserve is no longer relevant as this source no longer supplies drinking water. This review recommends that the Moora Eastern Water Reserve is abolished.

## 2.2 Consolidated recommendations

Based on the findings of this review and a change in the department's policy to protect and proclaim confined aquifer sources of drinking water, the following recommendations are proposed. The bracketed stakeholders are those expected to have a responsibility for, or an interest in, the implementation of that recommendation.

1. Proclaim the boundary of the proposed Moora Water Reserve under the *Country Areas Water Supply Act 1947*. (Department of Water)
2. Abolish (deproclaim) the Moora Eastern Water Reserve under the *Country Areas Water Supply Act 1947*. (Department of Water)
3. Maintain signs along the boundary of the proposed Moora Water Reserve, and ensure signs include an emergency contact telephone number. (Water Corporation)
4. Continue to maintain the bore compounds. (Water Corporation)
5. Update this drinking water source protection review after five to seven years. (Department of Water)

# Appendices

## Appendix A – Figures

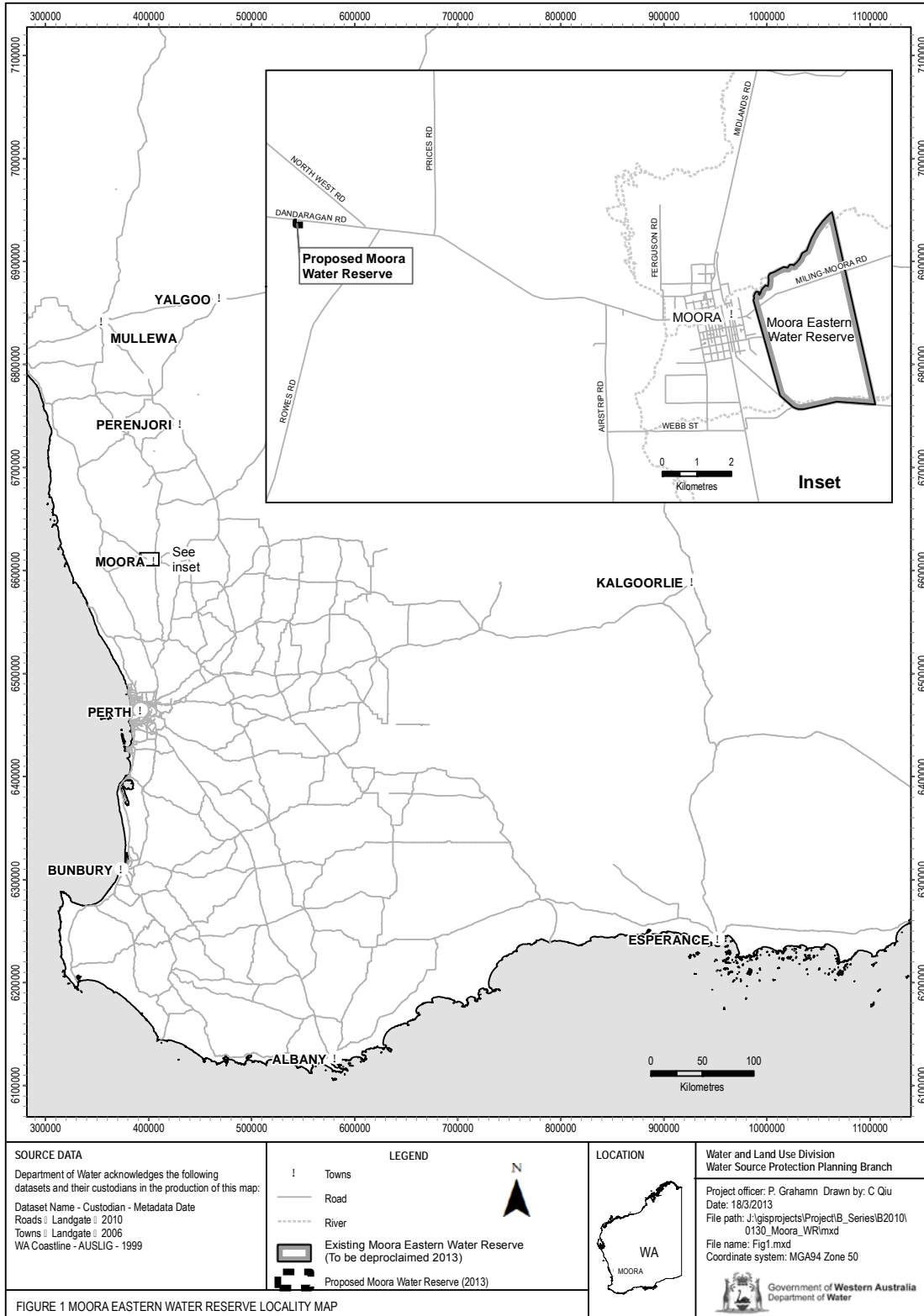


Figure 1 Moora Eastern Water Reserve and proposed Moora Water Reserve locality map





Figure 2 Moora Eastern Water Reserve and proposed Moora Water Reserve



Figure 3 Proposed Moora Water Reserve aerial photo

## 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 Moora 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 Moora (Kolburn 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 Moora, refer to the most recent Water Corporation drinking water quality annual report at [watercorporation.com.au](http://watercorporation.com.au) > What we do > Water quality > Water quality publications > Most recent *Water quality annual report*.

### *Aesthetic characteristics*

The aesthetic quality analyses for raw water from Moora (Kolburn bore field) are summarised in the following table.

#### *Aesthetic detections for Moora (Kolburn bore field)*

Parameter	Units	ADWG aesthetic guideline value*	Moora (Kolburn bore field) raw water	
			Range	Median
Chloride	mg/L	250	225– <b>250</b>	230
Colour (true)	TCU	15	<1– <b>60</b>	<1
Hardness as CaCO <sub>3</sub>	mg/L	200	55–66	57.5
Iron unfiltered	mg/L	0.3	<b>7.4–10</b>	<b>9</b>
Manganese unfiltered	mg/L	0.1	<b>0.22–0.26</b>	<b>0.24</b>
Sodium	mg/L	180	120–140	127.5
Sulfate	mg/L	250	24–28	26
Total filterable solids by summation	mg/L	500	449–494	468
Turbidity	NTU	5	3.6– <b>130</b>	<b>33</b>
pH measured in laboratory	no units	6.5–8.5	<b>5.76–6.36</b>	6.03

\* 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 Moora (Kolburn 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 Moora (Kolburn bore field)

Parameter	Units	ADWG health guideline value*	Moora (Kolburn bore field) raw water	
			Range	Median
Barium	mg/L	0.7	0.19–0.2	0.195
Boron	mg/L	4	0.04	0.04
Iodide	mg/L	0.1	0.14–0.18	0.16
Manganese unfiltered	mg/L	0.5	0.22–0.26	0.24
Nitrite as nitrogen	mg/L	0.91	<0.002–0.014	<0.0035
Nitrite plus nitrate as N	mg/L	11.29	<0.002–0.014	<0.05
Sulfate	mg/L	500	24–28	26

\* 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 Moora (Kolburn bore field) is currently conducted on a monthly basis. *Escherichia coli* counts are used as an indicator of the degree of recent faecal contamination of the raw water from warm-blooded animals.

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

During the review period no positive *E. coli* counts were recorded.

## Appendix C – Photographs

All photographs by Phyllis Graham, Department of Water



*Photo 1 Bore 1/82 in the proposed Moora Water Reserve*



*Photo 2 Bore 1/82 and water treatment plant in the proposed Moora Water Reserve*



Photo 3 Bore 1/89 in the proposed Moora Water Reserve



Photo 4  
Bore 1/89 in the proposed  
Moora Water Reserve



Photo 5 Treated water storage tanks in the proposed Moora Water Reserve



Photo 6 External signage at the proposed Moora Water Reserve



## List of shortened forms

<b>ADWG</b>	<i>Australian drinking water guidelines</i>
<b>ARMCANZ</b>	Agriculture and Resource Management Council of Australia and New Zealand
<b>GDA</b>	Geocentric Datum of Australia
<b>GPS</b>	The global positioning system
<b>kL</b>	kilolitre
<b>km</b>	kilometre
<b>m</b>	metres
<b>mg/L</b>	milligram per litre
<b>MGA</b>	Map Grid of Australia (1994)
<b>NHMRC</b>	National Health and Medical Research Council
<b>NRMMC</b>	Natural Resource Management Ministerial Council
<b>NTU</b>	nephelometric turbidity units
<b>P1</b>	priority 1
<b>P2</b>	priority 2
<b>PDWSA</b>	public drinking water source area
<b>TCU</b>	true colour units
<b>TDS</b>	total dissolved solids
<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</i> , 2011 (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 hole 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 called a wellfield).
<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>Confined aquifer</b>	An aquifer that is confined between non-porous rock formations (such as shale and siltstone) and therefore contains water under pressure.
<b>Drinking water source protection report</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. There are three types of reports, drinking water source protection assessment, drinking water source protection plan and drinking water source protection review.
<b>Geocentric Datum of Australia</b>	Geocentric Datum of Australia is the current national standard, as applied through both geographic and projected coordinate systems.

<b>The global positioning system</b>	The global positioning system is a space-based satellite navigation system that provides location information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites.
<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>mg/L</b>	A milligram per litre (0.001 grams per litre) is a measurement of a total dissolved solid in a solution.
<b>Map Grid of Australia</b>	The Map Grid of Australia (1994) is used to display geographical coordinates using Cartesian coordinates (easting, northings).
<b>Nephelometric turbidity units</b>	Nephelometric turbidity units are a measure of turbidity in water.
<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>	The area from which water is captured to supply drinking water. It includes all underground water pollution control areas, catchment areas and water reserves constituted under the <i>Metropolitan Water Supply, Sewerage, and Drainage Act 1909</i> 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>Total dissolved solids</b>	Total dissolved solids (TDS) consist of inorganic salts and small amounts of organic matter that are dissolved in water. Clay particles, colloidal iron and manganese oxides, and silica fine enough to pass through a 0.45 micrometre filter membrane can also contribute to TDS. TDS comprise sodium, potassium, calcium, magnesium, chloride, sulfate, bicarbonate, carbonate, silica, organic matter, fluoride, iron, manganese, nitrate (and nitrite) and phosphate (NHMRC & NRMMC 2011).

<b>Total filterable solids by summation</b>	Total filterable solids by summation is a water quality test which is a total of the following ions: Na (sodium), K (potassium), Ca (calcium), Mg (magnesium), Cl equivalent (chloride), alkalinity equivalent, SO <sub>4</sub> equivalent (sulfate) or S (sulfur) in grams, Fe (iron), Mn (manganese), and SiO <sub>2</sub> (silicon oxide). It is used as a more accurate measure than total dissolved solids (TDS). The higher the value, the more solids that are present and generally the saltier the taste.
<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>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>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.

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## Further reading

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