



Government of **Western Australia**
Department of **Water**

Looking after all our water needs



New Norcia Water Reserve drinking water source protection plan

New Norcia Water Reserve town water supply



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Department of Water

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Department of Water

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All maps in this publication were produced by the Department of Water with the intent that they be used for the New Norcia Water Reserve drinking water source protection plan at the scale shown on the maps. While the Department of Water has made all reasonable efforts to ensure the accuracy of data in this report, no responsibility is accepted for any inaccuracies, and persons relying on them do so at their own risk.

For more information about this report, contact the Department of Water (Water Source Protection Branch) on +61 8 6364 7600 or send your enquiry to drinkingwater@water.wa.gov.au.

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Preface

The Department of Water has prepared this drinking water source protection plan to assess risks to water quality within the New Norcia Water Reserve and to recommend management strategies to avoid, minimise or manage those risks. The department is committed to protecting drinking water sources to meet public health requirements and ensure the supply of safe, reliable, good quality drinking water to consumers.

The *National water quality management strategy: Australian drinking water guidelines 6, 2004* (NHMRC & NRMCC 2004a) recommends a risk-based, multiple-barrier approach to protect public drinking water sources. Catchment protection is the first barrier against contamination, with subsequent barriers implemented at the water storage, treatment and distribution stages of a water supply system. Catchment protection requires an understanding of the catchment and the hazards that can compromise drinking water quality. It then requires the development of preventative strategies and operational controls to ensure the safest possible water is supplied to consumers.

This plan details the location and boundary of the drinking water source providing potable water to the New Norcia town water supply. It discusses existing and future use of the water source, describes the water supply system, identifies risks and recommends management approaches to address these risks and protect the water source.

This plan has been prepared to help guide state and local government land-use planning and development decisions. It should be recognised in the *Shire of Victoria Plains local planning scheme*, consistent with the Western Australian Planning Commission's *Statement of planning policy 2.7: Public drinking water source policy*. Other stakeholders should use this document as a guide for protecting the quality of water in the recommended New Norcia Water Reserve.

The stages involved in preparing a drinking water source protection plan are:

Stages in development of a plan		Comment
1	Prepare first New Norcia drinking water source protection plan. (1999)	Published in 1999 by the Water and Rivers Commission (now the Department of Water).
2	Undertake a review of the 1999 New Norcia plan. (December 2008)	Review land use changes and assessment of water requirements.
3	Conduct stakeholder consultation. (February 2009)	Advice sought from key stakeholders using the previous plan as a tool for information and discussion.
4	Prepare draft drinking water source protection plan. (February 2009)	Draft protection plan developed taking into account input from stakeholders and any additional advice.
5	Release draft drinking water source protection plan. (April 2009)	Draft protection plan released for a four-week public consultation period.
6	Publish approved drinking water source protection plan. (June 2009)	Final protection plan published after considering submissions. Includes recommendations on how to protect water quality. Proclamation of the public drinking water source area can now occur.

Summary

The town of New Norcia is located about 120 km north of Perth in the central Wheatbelt area of Western Australia (Figure 1). The town water supply is obtained from a Water Corporation wellfield north of Yenart Road (Figure 2). The wellfield consists of two production bores in an unconfined aquifer occupying a shallow paleochannel, which is vulnerable to contamination (Figure 3).

The existing wellfield was subject to a water source protection plan finalised in 1999, but the water reserve proposed in that document was never proclaimed. This plan updates and replaces the plan completed in 1999. The Water Corporation undertakes regular water quality monitoring and surveillance of the wellfield. The water reserve proposed in this plan is located on private property (Figure 4).

The land uses on this property are low-intensity livestock grazing and broadacre cropping. There is also a tagasaste plantation, which is a remnant crop from previous landowners and is not currently being used for cattle fodder. The contamination risks associated with the current agricultural land uses are considered low and manageable for maintenance of water quality.

This plan recommends that the proposed New Norcia Water Reserve be gazetted under the *Country Areas Water Supply Act 1947 (WA)* to help protect the drinking water supply for the town of New Norcia. The water reserve boundary has been defined on the basis of local hydrogeology and hydrology. The proposed boundary encompasses the paleochannel within which direct recharge to the superficial aquifer occurs and areas to the north and south of the paleochannel where topography causes water to drain into the paleochannel and subsequently recharge the aquifer.

It is recommended that the paleochannel be classified as a priority 1 (P1) area with wellhead protection zones around bores 20/90 and 21/90 (Figure 5). This classification correlates with the strategic importance of the area. The paleochannel overlies a shallow aquifer that is vulnerable to contamination from inappropriate land uses, and development is undesirable given the close proximity of production bores.

It is further recommended that the area north and south of the paleochannel be classified as a priority 2 (P2) area (Figure 5). As the land is privately owned and zoned rural, a P2 classification ensures that compatible development rights are provided for. In this area, the Department of Water suggests that existing landowners implement best-management practices to protect water quality.

This protection plan recommends:

- The proposed water reserve boundary should be gazetted under the *Country Areas Water Supply Act 1947 (WA)*.

- The water reserve boundary, priority areas, wellhead protection zones and management principles outlined in this plan should be recognised in the *Shire of Victoria Plains town planning scheme*.
- All development proposals within the New Norcia Water Reserve that are inconsistent with the Department of Water's *Water quality protection note: Land use compatibility in public drinking water source areas* or recommendations in this plan should be referred to the Department of Water for comment.
- The New Norcia Groundwater Area proclaimed under the *Rights in Water and Irrigation Act 1914* should be amended to include all of the proposed water reserve.
- Existing landowners within the proposed water reserve should be encouraged to implement best-management practices.

1 Drinking water source overview

1.1 Existing water supply system

The New Norcia drinking water supply is located about 6.5 km south-east of the town of New Norcia and consists of two production bores: B 20/90 and B 21/90 (Figure 2). The bores are located approximately 250 m apart and pump from an unconfined aquifer. Bore 20/90 is 20 m deep and is currently used as the duty bore because of its better water quality (see Appendix B Photo 1), while bore 21/90 is 32 m deep and is currently used for stand-by purposes.

Previously, the water supply for New Norcia was obtained from the Calingiri Road Dam and in times of severe drought or water shortage, also from Milners Lake. Now the Calingiri Road Dam is used for lawn irrigation, public toilet facilities and the town swimming pool.

1.2 Water treatment

Water from the proposed New Norcia Water Reserve is disinfected by chlorination before it is pumped to a 225 kL storage tank. Water then gravitates into the town from the tank.

It should be recognised that although treatment and disinfection are essential barriers against contamination, catchment management is the first step in protecting water quality and thus ensuring a safe drinking water supply. This approach is endorsed by the *National water quality management strategy: Australian drinking water guidelines 6, 2004* (ADWG) (NHMRC & NRMCC 2004a) and reflects a risk-based, catchment-to-consumer, multiple-barrier approach for providing safe drinking water to consumers. The combination of catchment protection and water treatment delivers a more reliably safe drinking water to consumers than either could achieve individually.

1.3 Catchment details

1.3.1 Physiography

The town of New Norcia is located 120 km north of Perth on the Great Northern Highway (Figure 1). The landscape has moderate relief from about 200 m to 295 m above sea level and is extensively dissected by the Moore River drainage system, of which many creeks are saline. Most of the area is cleared for farming, however, native vegetation has been retained along some drainages and where massive laterite or basement rock crops out (Thorpe 1991).

1.3.2 Climate

The New Norcia region experiences a Mediterranean-type climate with hot, dry summers and cool, wet winters. The average rainfall is approximately 530 mm/year and the potential pan evaporation is about 2300 mm/year.

1.3.3 Hydrogeology

New Norcia lies on the western margin of the Yilgarn Craton. In the area of the wellfield, the bedrock consists of granite and gneiss. The weathered profile, averaging 30 m in thickness, consists of clayey sand and sandy clay. A paleochannel occupies a depression in the weathered bedrock surface. This channel has an estimated length of 1.2 km, width of 400 m and trends south-west. Drilling has shown that the channel's margins are steeply incised.

The aquifer used for the New Norcia town water supply is unconfined and consists of fluvial paleochannel deposits overlain by eolian yellow sand. Recharge to the aquifer is by direct rainfall infiltration into the yellow sand, primarily in the area of the paleochannel. It is estimated that 40 per cent of the annual rainfall over the paleochannel reaches the watertable as recharge.

1.4 Future water supply requirements

The previously proposed New Norcia Water Reserve is suitable for the current water supply needs of New Norcia. At present there is no likely increase in demand that would require an increase in the Water Corporation's current licensed allocation of 30 000 kL per annum.

1.5 Existing drinking water source protection

A drinking water source protection plan was developed for the New Norcia Water Reserve in 1999 by the Water and Rivers Commission (now the Department of Water). However, the water reserve delineated in that plan (Figure 2) was never proclaimed under the *Country Areas Water Supply Act 1947* (WA).

The Water Corporation currently undertakes regular surveillance and water quality monitoring. There is also fencing surrounding the bore compound (see Appendix B Photo 1).

1.6 Department of Water management

1.6.1 Current allocation licence

Water resource use and conservation in Western Australia is administered by the Department of Water in accordance with the *Rights in Water and Irrigation Act 1914* (WA). Under the Act, the right to use and control surface water and groundwater is

vested with the Crown. The Act requires licensing of groundwater abstraction (pumping water from a bore, spring or soak) within proclaimed groundwater areas.

The previously proposed New Norcia Water Reserve is located within the proclaimed New Norcia Groundwater Area. However, the eastern portion of the proposed New Norcia Water Reserve lies outside the proclaimed groundwater area. The Water Corporation is currently licensed to draw 30 000 kL per annum from the New Norcia wellfield for public water supply purposes in accordance with Groundwater Well Licence 62155(3). The number of domestic services supplied in 2007-08 was one. This service is to the main water meter for the New Norcia Benedictine community.

The abstraction of groundwater under this licence is undertaken in accordance with the New Norcia Resource Management Operation Strategy, which has been approved by the Department of Water.

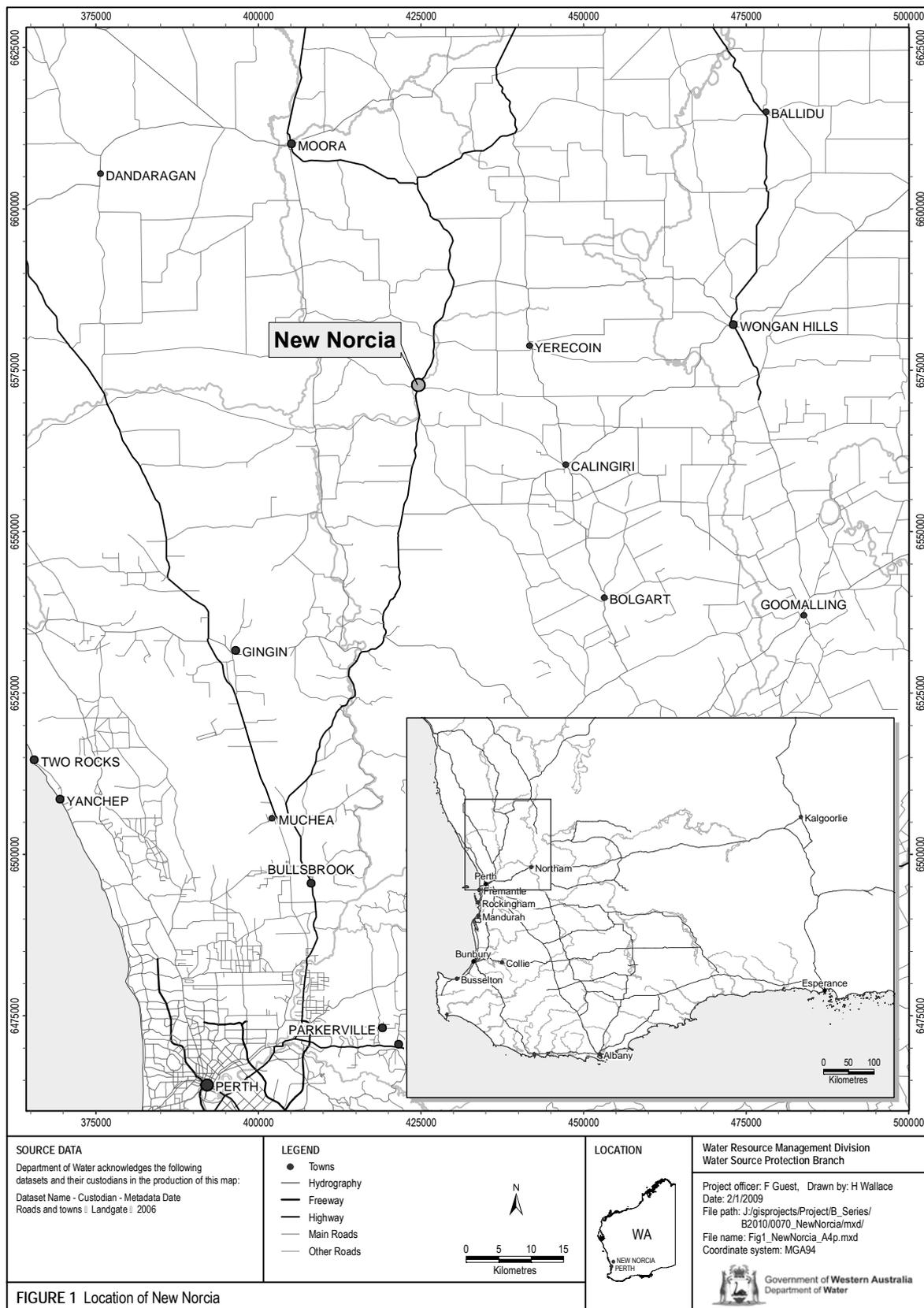


Figure 1 New Norcia Water Reserve Locality map

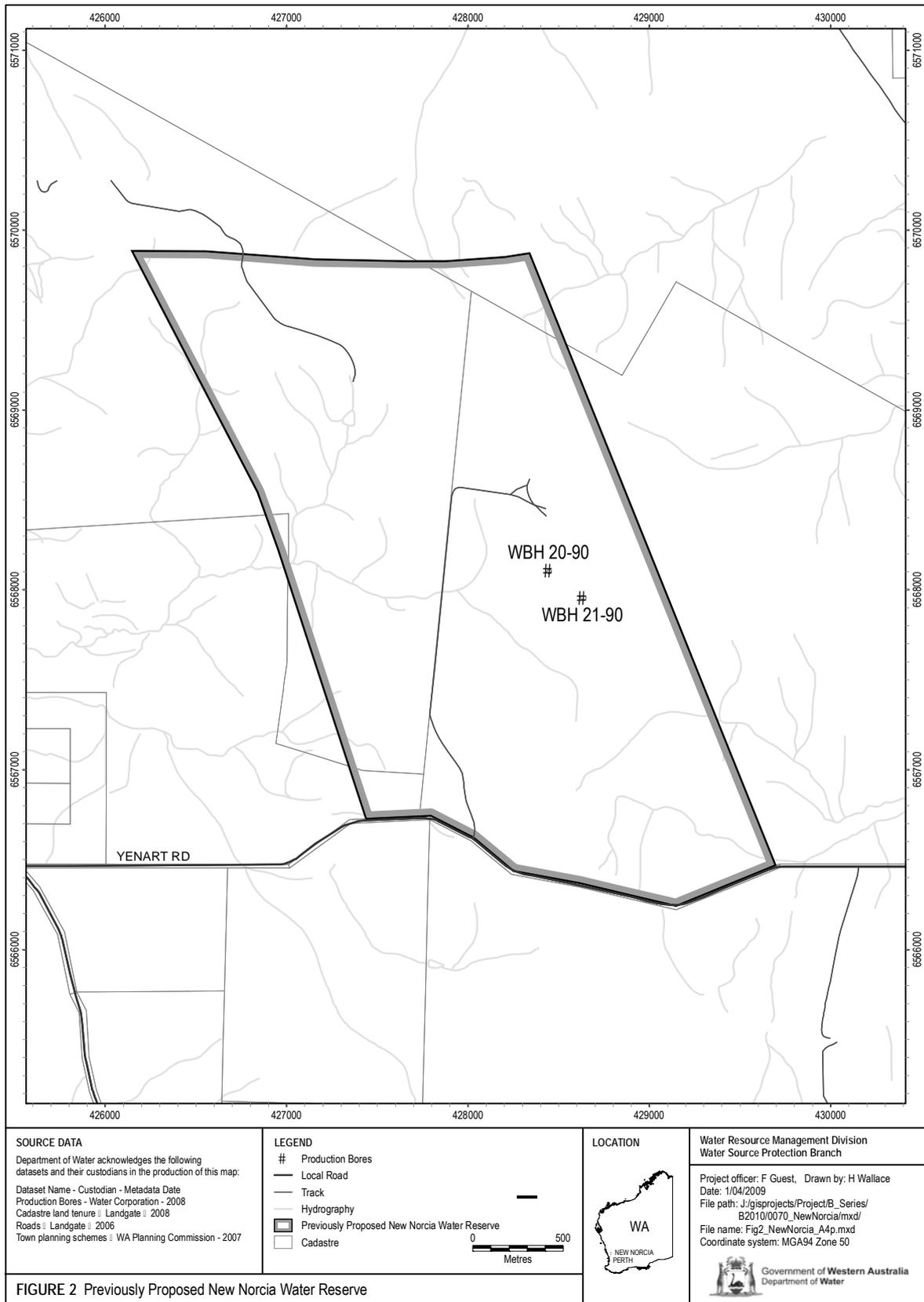


Figure 2 Previously proposed New Norcia Water Reserve

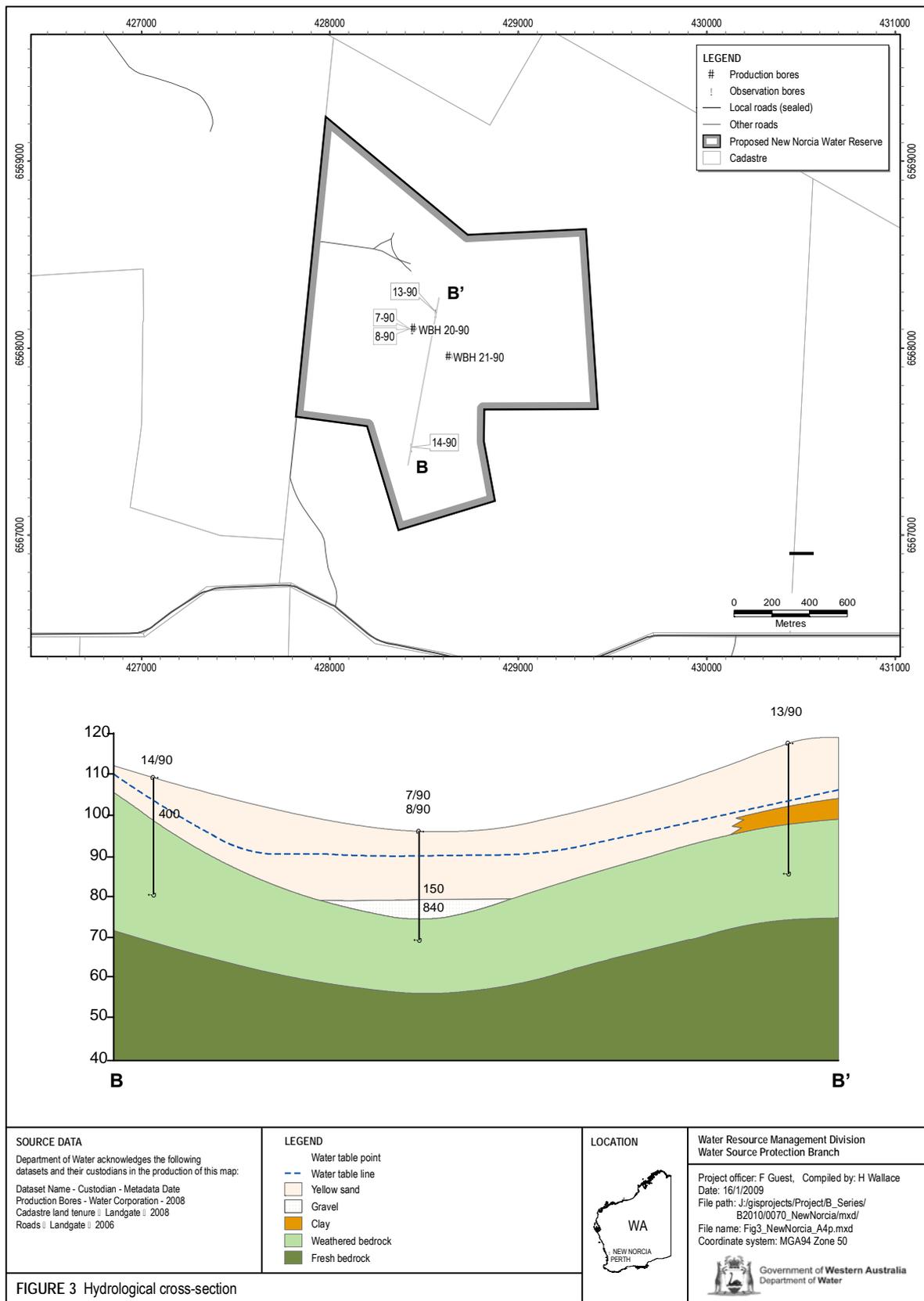


Figure 3 Hydrogeological Cross-section

2 Water quality monitoring and contamination risks

A wide range of chemical, physical and microbiological factors can impact on water quality and therefore affect the provision of safe, quality, aesthetically acceptable drinking water to consumers.

The Water Corporation regularly monitors the quality of raw water from the New Norcia Water Reserve for microbiological, health-related and aesthetic (non-health-related) characteristics, in accordance with the ADWG. Monitoring results from treated water are reviewed by an intergovernmental committee known as the Advisory Committee for the Purity of Water, which is chaired by the Department of Health.

A water quality summary for the New Norcia Water Reserve from January 2004 to December 2008 is presented in Appendix A. For more information on water quality, see the Water Corporation's most recent drinking water quality annual report at <www.watercorporation.com.au> Publications > Water quality > Water quality annual report.

Contamination risks relevant to the New Norcia Water Reserve are described below.

2.1 Microbiological

Pathogens are micro-organisms that are capable of causing diseases and include bacteria, protozoa and viruses. In water supplies, pathogens that can cause illness are mostly found in the faeces of humans and domestic animals (such as dogs and cattle).

A number of pathogens are commonly known to contaminate water supplies around the world. These include bacteria (e.g. salmonella, *Escherichia coli*, cholera), protozoa (e.g. cryptosporidium, giardia) and viruses. *E. coli* counts are a way of measuring these pathogens and are an indicator of faecal contamination. Water analyses from the New Norcia borefield show that less than two per cent of samples had positive detections of *E. coli*.

Pathogen contamination of a drinking water source is influenced by many factors such as the existence of pathogen carriers (e.g. humans and domestic animals), the transfer to and movement of the pathogen in the water source and its ability to survive in the water. The percentage of humans in the world that carry pathogens varies. For example, it is estimated that between 0.6 to 4.3 per cent of people are infected with cryptosporidium worldwide, and 7.4 per cent with giardia (Geldreich 1996).

When people (while fishing, marroning, swimming or the like) or domestic animals come into contact with a body of water, pathogens may enter that water source. This

primarily occurs through the direct transfer of faecal material (even a very small amount can cause contamination) or indirectly through runoff moving faecal material into the water.

The ability of pathogens to survive in surface water also differs between species. Salmonella may be viable for two to three months, giardia may still infect after one month in the natural environment (Geldreich 1996) and cryptosporidium oocysts (cells containing reproductive spores) may survive weeks to months in freshwater (NHMRC & NRMCC 2004a).

When people consume drinking water contaminated with pathogens, the effects vary considerably: ranging from mild illness (such as stomach upset or diarrhoea) to death. In 2000 in Walkerton, Canada, seven people died due to contamination of the town water source and supply by a pathogenic strain of *E. coli* and campylobacter (NHMRC & NRMCC 2004b). Preventing the introduction of pathogens into the water source through catchment protection measures is the most effective barrier in avoiding this public health risk.

2.2 Health related

Pesticides include agricultural chemicals such as insecticides, herbicides, nematicides (used to control worms), rodenticides and miticides (used to control mites). Contamination of a drinking water source by pesticides (and other chemicals) may occur as a result of accidental spills and/or incorrect use, overuse or leakage from storage areas. In such cases, the relevant authorities should be notified promptly and the spill cleaned up.

Drinking water supplies can be contaminated by nutrients (such as nitrogen) as a result of leaching from fertiliser applications, faulty septic systems, leach drains and from domestic animal faecal matter that washes through or over soil and into the water source. Nitrate and nitrite (ions of nitrogen) can be toxic to humans at high levels, with infants younger than three months being most susceptible (NHMRC & NRMCC 2004a).

New Norcia has been granted exemption from compliance with nitrate guidelines and hence the supply should not exceed a nitrate (Nitrate as N) concentration of 22.5 mg/L. However, nitrate (Nitrate as N) concentrations between 11.3 and 22.5 mg/L can cause adverse health effects in infants under three months of age (ADWG 2004). As a result, in New Norcia the Community Nurse advises nursing mothers about using alternative water to prepare bottle feeds. The Water Corporation provides bottled water free-of-charge through the Community Nurse as required.

Hydrocarbons can occur in water supplies as a result of spills and leakage from vehicles (e.g. fuels, oils) and are potentially toxic to humans. Harmful chemical by-products may be formed when hydrocarbons are combined with chlorine, which is used in the water-treatment processes.

2.3 Aesthetic

Impurities in drinking water can affect its aesthetic qualities, including its appearance, taste, smell and feel. Such impurities are not necessarily hazardous to human health; for example, cloudy water with a distinctive odour or a strong taste is not necessarily harmful to health, while clear, pleasant-tasting water may still contain harmful micro-organisms (NHMRC & NRMCC 2004b).

Iron and dissolved organic matter can affect the colour and appearance of water and salinity can affect the taste. Some properties such as pH (a measure of acidity or alkalinity) can contribute to the corrosion and encrustation of pipes.

The ADWG sets aesthetic water quality criteria to meet the aesthetic requirements of consumers and to protect water supply infrastructure (such as pipes).

2.4 Groundwater bores

The New Norcia Water Reserve is located within the New Norcia Groundwater Area, which is proclaimed under the *Rights in Water and Irrigation Act 1914* (WA). Under the provisions of sections 26D and 5C of the Act, a licence is required to construct a bore or extract water within a proclaimed groundwater area (unless exempt under the *Rights in Water and Irrigations Act 1914* Exemption and Repeal (Section 26C) Order 2001).

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

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

3 Land-use assessment

3.1 Existing land uses and activities

The New Norcia wellfield is located on private land used for sheep grazing and broadacre cropping (grain). The aquifer is highly vulnerable to contamination from inappropriate land uses. The contamination risks associated with the current agricultural land uses are considered medium to high. Best-management practice should be encouraged to ensure the water quality is protected.

3.1.1 Private land

Sheep grazing

The southern area of the proposed water reserve is currently used for low-intensity sheep grazing (see Appendix B Photo 2). Potential contamination risks associated with this land use include nutrients and pathogens from animal manure.

Broadacre cropping

Grain crops, such as lupins, oats and barley, are located north to north-east of the proposed water reserve. The impact of this land use is minimal due to the distance from the proposed water reserve. However, a potential contamination risk exists through the application of fertilisers and pesticides. The landowners are aware of this risk and have been provided with information relating to best-management practice.

Tagasaste plantation

East of the proposed water reserve is a tagasaste plantation (see Appendix B Photo 3). In the draft report it was stated that this vegetation has the ability to leach nitrates and may be linked to the high nitrate concentrations found in the water supply (Department of Agriculture and Food 2005). Subsequent research undertaken by the Department of Agriculture and Food has shown that this is not the case (Department of Agriculture and Food 2009). It is recommended that the growth of perennial grasses be encouraged to counteract the high nitrate levels in the groundwater.

Roads

There is one access road for the water reserve, which is maintained weekly by the landowners. Although the dirt road is currently in good condition, it has been suggested that gravel may be a more appropriate surface. An agreement in relation to the ongoing maintenance of the road needs to be established between the Water Corporation and the landowners.

The most significant risk associated with this road is hydrocarbon contamination from fuel and chemical spills. Ensuring the road is in good condition at all times, will keep this risk low.

3.1.2 Native title

Native title is a form of land title that recognises the unique ties some Aboriginal groups have to land. Native title exists where Aboriginal people have maintained a traditional connection with their land and waters, since sovereignty, and where acts of government have not removed it.

There is one native title claim within the proposed New Norcia Water Reserve. This claim is Yued Peoples (WAD6192/98).

3.2 Proposed land uses and activities

The future land use within the New Norcia Water Reserve is likely to be a continuation of the existing rural activities.

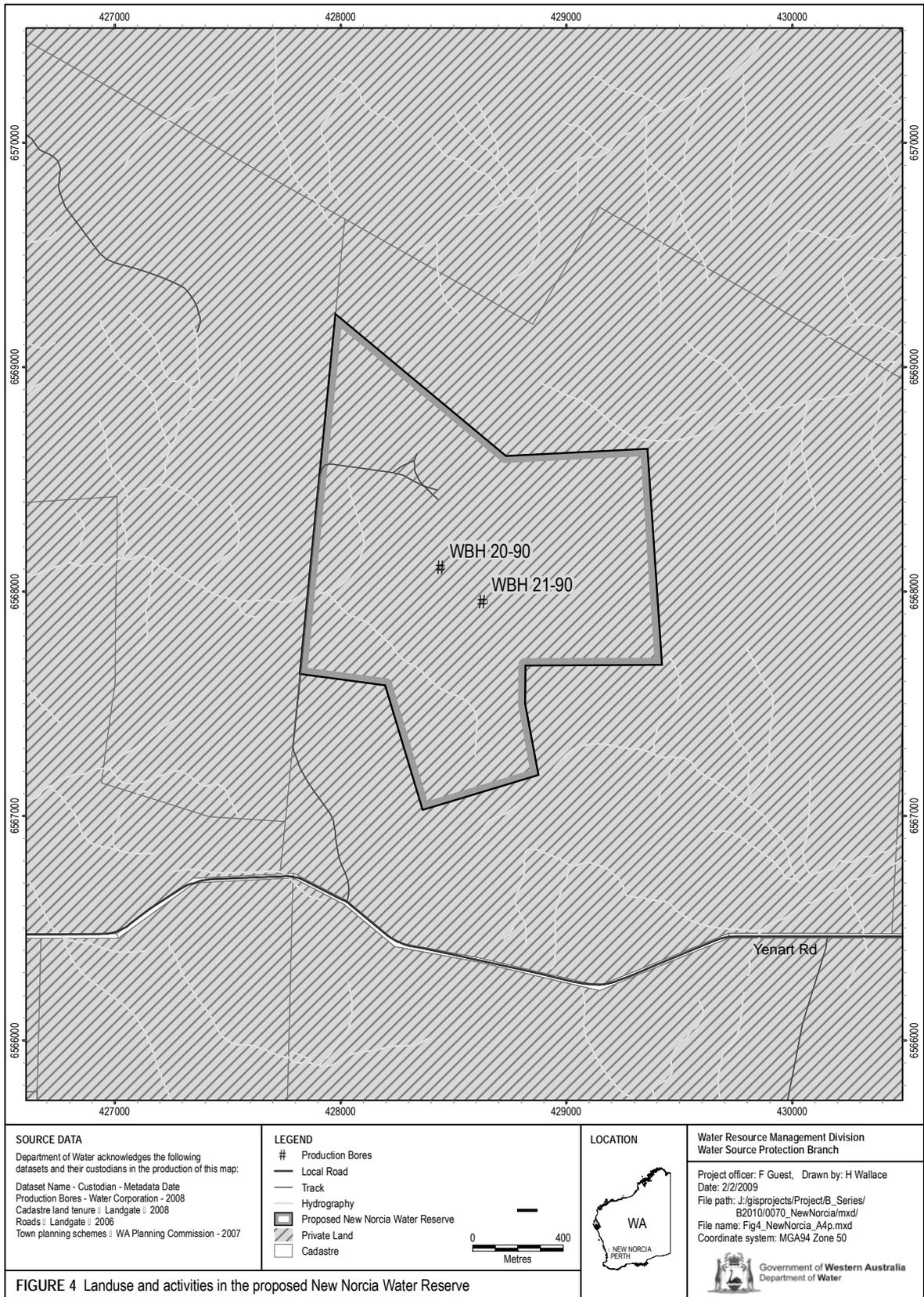


Figure 4 Land use and activities in the proposed New Norcia Water Reserve

Table 1 Land use, potential water quality risks and recommended protection strategies

Land use/activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Roads: <ul style="list-style-type: none"> • access road to water reserve. 	Contamination from fuel and chemical spills.	Low	The road is maintained on a weekly basis.	<ul style="list-style-type: none"> • Speed limit of 30 km per hour imposed with signage. 	<ul style="list-style-type: none"> • Agreement reached between the landowners and Water Corporation to ensure the road continues to be maintained regularly.
Livestock grazing: <ul style="list-style-type: none"> • sheep grazing. 	Pathogens from animal manure. Nutrients from animal manure.	Medium/high Medium/high	Livestock grazing is the primary land use within the proposed water reserve. The stocking rates are usually low.	<ul style="list-style-type: none"> • Water quality monitoring. • Fenced bore compound. • Chlorination. 	<ul style="list-style-type: none"> • Best-management practice. • Maintain low stocking rates within the proposed water reserve.

Land use/activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Broadacre cropping: <ul style="list-style-type: none"> • lupins • oats • barley. 	Nutrients from fertiliser application. Pesticide and herbicide use.	Medium Medium	There are no crops grown within the proposed water reserve.	<ul style="list-style-type: none"> • Water quality monitoring. • Fenced bore compound. • Chlorination. 	<ul style="list-style-type: none"> • Pesticides should be applied in accordance with <i>Statewide policy No. 2. Pesticide use in public drinking water source areas</i> and the Department of Health's PSC 88: <i>Use of herbicides in water catchment areas</i>. • Reference should be made to water quality protection notes: <i>Agriculture – dryland crops near sensitive water resources</i> and <i>Nutrient and irrigation management plans</i>.

4 Catchment protection strategy

4.1 Protection objectives

The objective of this plan is to protect the New Norcia Water Reserve to ensure safe drinking water for the town of New Norcia, while recognising the rights of existing approved land uses to continue.

4.2 Proclaimed area

A drinking water source protection plan was developed for the New Norcia Water Reserve in 1999 by the Water and Rivers Commission (now the Department of Water). However, the water reserve delineated in that plan (Figure 2) was never proclaimed under the *Country Areas Water Supply Act 1947* (WA).

The New Norcia Water Reserve proposed in this protection plan (Figure 4) encompasses the paleochannel within which direct recharge to the superficial aquifer occurs. The water reserve boundary also includes areas to the north and south of the paleochannel where topography causes water to drain into the paleochannel and subsequently recharge the aquifer.

It is proposed that this water reserve boundary is proclaimed under the *Country Areas Water Supply Act 1947* (WA) for the purpose of protecting the public drinking water source. Proclamation enables the *Country Areas Water Supply By-laws 1947* to be applied to potentially polluting activities within the New Norcia Water Reserve.

4.3 Priority areas

The protection of public drinking water source areas (PDWSAs) relies on statutory and non-statutory measures available in legislation for water resource management and land-use planning. The Department of Water's policy for the protection of PDWSAs includes three risk-based priority areas:

- Priority 1 (P1) areas have the fundamental water quality objective of risk avoidance.
- Priority 2 (P2) areas have the fundamental water quality objective of risk minimisation.

The determination of priority areas is based on the strategic importance of the land or water source, the local planning-scheme zoning, the form of land tenure and existing approved land uses or activities. For further details, please refer to the Department of Water's *Water quality protection note: Land use compatibility in public drinking water sources areas*.

The priority areas for the New Norcia Water Reserve have been determined in accordance with current Department of Water policy. These areas are described below and displayed in Figure 5. The department's *Water quality protection note: Land use compatibility in 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 the aforementioned water quality protection note.

The proposal involves classifying the paleochannel, where direct recharge of the superficial aquifer occurs, as P1. This classification correlates with the strategic importance of the area (Figure 5). The paleochannel overlies a shallow aquifer that is vulnerable to contamination from inappropriate land uses, and development is undesirable given the close proximity of production bores.

The P1 classification has been discussed with the landowners. They are aware of the importance of the area and agree it should be given the highest level of protection possible. The water supply for the landowners is also located within the P1 area.

The proposal also seeks to classify the area north and south of the paleochannel, where drainage into the paleochannel occurs, as P2 (Figure 5). As the land is privately owned and zoned rural, a P2 classification ensures that compatible development is provided for. Furthermore it allows for existing land uses to be managed for P2 source-protection objectives (risk minimisation) by implementing best-management practice.

4.4 Protection zones

Protection zones are defined to protect drinking-water sources from contamination in the immediate vicinity of water extraction facilities. By-laws of the *Country Areas Water Supply Act 1947* (WA) may prohibit, restrict or approve defined land uses and activities to prevent water source contamination or pollution. Specific conditions may apply within these zones such as restrictions on the storage of chemicals.

Wellhead protection zones (WHPZ) are used to protect groundwater sources. They 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. WHPZ do not extend outside the boundary of the water reserve.

A WHPZ with a 500 m radius around bores 20/90 and 21/90 is sought. Both these bores are located within the P1 area and are used for water supply purposes (Figure 5). All livestock should be kept out of the WHPZ.

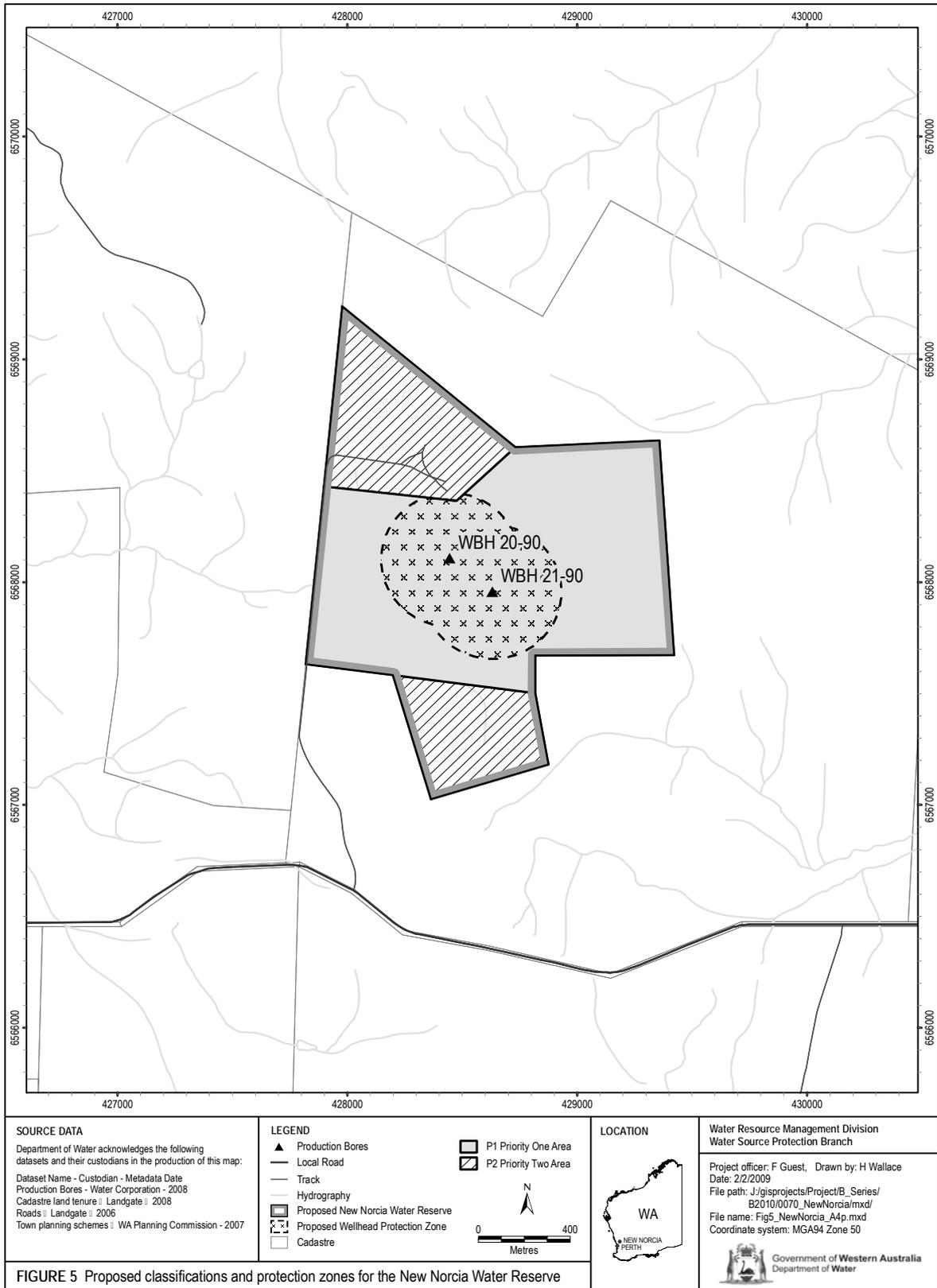


Figure 5 Proposed boundary, priority areas and protection zones for the New Norcia Water Reserve

4.5 Land-use planning

It is recognised under the *State planning strategy* (Western Australian Planning Commission 1997) that 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 *Statement of planning policy 2.7: Public drinking water source policy* (Western Australian Planning Commission 2003) it is appropriate that the New Norcia Water Reserve, priority areas and protection zones be recognised in the *Shire of Victoria Plains local planning scheme*. Any development proposals within the New Norcia Water Reserve that are inconsistent with advice in the Department of Water's *Water quality protection note: Land use compatibility in public drinking water source areas* or recommendations in this plan, should be referred to the Department of Water. For further information on land-use planning and water source protection, please refer to the Department of Water's *Water quality protection note: Protecting public drinking water source areas*.

The department's protection strategy for public drinking water source areas (PDWSAs) provides for lawfully established and operated developments to continue - despite their location or facilities posing a level of risk to water quality that would not be accepted for new developments. The department may negotiate with landowners/operators on measures to improve these facilities and reduce water quality contamination risks.

In strategically significant areas the department has developed a policy that allows it to approach landowners with a view to buying land or negotiating water-contamination-risk reduction measures.

4.6 Best-management practices

There are opportunities to significantly reduce water contamination risks by carefully considering design and management practices. The Department of Water will continue to encourage the adoption of best-management practices for various land uses. On freehold land, the department aims to work with landowners by providing advice on achieving sound management practices for the protection of water quality.

Guidelines on best-management practices for many land uses are available in the form of industry codes of practice, environmental guidelines and water quality protection notes. These have been developed in consultation with stakeholders such as industry groups, agricultural producers, state government agencies and technical advisers. Examples include:

- *Water quality protection note: Agriculture – dryland crops near sensitive water resources* (Department of Water 2006)
- *Water quality protection note: Nutrient and irrigation management plans* (Department of Water 2006)

- *Water quality protection note: Stockyards* (Department of Water 2006)
- *Statewide policy No. 2: Pesticide use in public drinking water source areas* (Water and Rivers Commission 2000)

These documents are listed in this report's Bibliography. The guidelines outline the recommended practices to ensure the protection of water quality and therefore help managers reduce any detrimental effects of their operations.

Education and creating awareness (e.g. signage and information) are also key mechanisms for protecting water quality, especially for those people visiting the area who are unfamiliar with the New Norcia Water Reserve. A brochure will be produced once this plan is endorsed, describing the New Norcia Water Reserve, its location and the main threats to water quality. This brochure will be available to the community and will inform people in simple terms of the drinking water source and the need to protect it.

4.7 Surveillance and by-law enforcement

The quality of public drinking water sources within country areas of the state is protected under the *Country Areas Water Supply Act 1947 (WA)*. Proclamation of PDWSAs allows existing by-laws to be applied to protect water quality.

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

Signs are erected on the boundaries of PDWSAs to educate and advise the public about activities that are prohibited or regulated. This plan recommends the delegation of surveillance and by-law enforcement to the Water Corporation.

4.8 Emergency response

The escape of contaminants during unforeseen incidents and the use of chemicals during emergency responses can result in water contamination. The Shire of Victoria Plains local emergency management committee (LEMC), through the Wheatbelt emergency management district, should be familiar with the location and purpose of the New Norcia Water Reserve. A locality plan should be provided to the fire and rescue services headquarters for the hazardous materials (HAZMAT) emergency advisory team. The Water Corporation's role should be to advise the HAZMAT team in relation to incidents in the New Norcia Water Reserve.

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

4.9 Implementation of this plan

Table 1 identifies the potential water quality risks associated with existing land uses in the New Norcia Water Reserve and recommends protection strategies to deal with these risks.

Following publication of the final *New Norcia Water Reserve drinking water source protection plan*, an implementation strategy will be drawn up based on the recommendations in Table 1. It will provide an indicative timeframe for the recommended protection strategies and identify stakeholders that could be involved in implementation actions.

5 Recommendations

The following recommendations apply to the entire New Norcia Water Reserve. The bracketed stakeholders are those expected to have an interest in implementing the relevant recommendation.

- 1 The boundary of the New Norcia Water Reserve should be proclaimed under the *Country Areas Water Supply Act 1947* (WA). (Department of Water.)
- 2 Prepare an implementation plan including the recommended protection strategies as detailed in Table 1 of this plan, showing responsible stakeholders and planned timeframes. (Department of Water, applicable stakeholders.)
- 3 The *Shire of Victoria Plains local planning scheme* should incorporate this plan and reflect the identified New Norcia Water Reserve boundary, priority 1 and 2 areas and protection zones in accordance with *Statement of planning policy 2.7: Public drinking water source policy*. (Shire of Victoria Plains.)
- 4 All development proposals within the New Norcia Water Reserve that are inconsistent with the Department of Water's *Water quality protection note: Land use compatibility in public drinking water source areas* or recommendations in this plan should be referred to the Department of Water for advice and recommendations. (Department for Planning and Infrastructure, Shire of Victoria Plains, proponents of proposals.)
- 5 Incidents covered by WESTPLAN–HAZMAT in the New Norcia Water Reserve should be addressed by ensuring that:
 - the Wheatbelt LEMC is aware of the location and purpose of the New Norcia Water Reserve
 - the locality plan for the New Norcia Water Reserve is provided to the FESA headquarters for the HAZMAT emergency advisory team
 - the Water Corporation acts in an advisory role during incidents in the New Norcia Water Reserve
 - personnel dealing with WESTPLAN–HAZMAT incidents in the area have ready access to a locality map of the New Norcia Water Reserve and information to help them recognise the potential impacts of spills on drinking water quality.(Department of Water and Water Corporation.)
- 6 The Water Corporation's existing monitoring program should be maintained to identify any incompatible land uses or potential threats within the New Norcia Water Reserve. (Water Corporation.)
- 7 A review of this plan should be undertaken after five years. (Department of Water.)
- 8 The New Norcia Groundwater Area proclaimed under the *Rights in Water and Irrigation Act 1914* (WA) should be amended to include all of the proposed water reserve. (Department of Water.)

Appendices

Appendix A Water quality data

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

The Water Corporation has monitored the raw (source) water quality from New Norcia borefield in accordance with the *National water quality management strategy: Australian drinking water guidelines 6, 2004* (ADWG) (NHMRC & NRMCC 2004a) and interpretations agreed to with the Department of Health. 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 in the New Norcia borefield. 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. Results that exceed the ADWG have been shaded to give an indication of potential raw-water quality issues associated with this source.

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. The values are taken from ongoing monitoring for the period January 2004 to December 2008.

Any water quality parameters that have been detected are reported; those that on occasion have exceeded the ADWG are shaded.

For more information on the quality of drinking water supplied to New Norcia, refer to the Water Corporation's most recent drinking water quality annual report at www.watercorporation.com.au/W/waterquality_annualreport.cfm

Aesthetic

The aesthetic quality analyses for raw water from New Norcia borefield are summarised in the following table.

Aesthetic detections for New Norcia borefield

Parameter	Units	ADWG aesthetic guideline value*	New Norcia borefield raw source SP	
			Range	Median
Aluminium unfiltered	mg/L	N/A	<0.032–0.91	0.35
Colour (true)	TCU	15	<1–6	<1
Conductivity	mS/m	–	51–115	84
Hardness as CaCO ₃ [†]	mg/L	200	97–107	107
Iron unfiltered	mg/L	0.3	<0.006–0.194	0.035
pH measured in laboratory	no unit	6.5–8.5	6.08–6.54	6.32
Sodium [†]	mg/L	180	120–130	130
Sulfate [†]	mg/L	250	18–19	18
Total filterable solids by summation [†]	mg/L	500	469–538	527
Turbidity	NTU	5	2.2–8	4

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

[†] Water quality data observed from three or less sampling occasions.

Health related

Health-related chemicals

Raw water from the New Norcia borefield is analysed for chemicals that are harmful to human health, including categories of chemicals such as inorganics, heavy metals, industrial hydrocarbons and pesticides. Health-related parameters that affect water quality are summarised in the following table.

Health-related detections for New Norcia borefield

Parameter	Units	ADWG health guideline value*	New Norcia borefield raw source SP	
			Range	Median
Barium [†]	mg/L	0.7	0.0025	0.0025
Boron [†]	mg/L	4	0.02	0.02
Fluoride	mg/L	1.5	<0.10–0.2	0.2
Nitrate as nitrogen	mg/L	11.29	6.5–17	14
Nitrite plus nitrate as N	mg/L	11.29	11–16	14.5
Nitrite as nitrogen	mg/L	0.91	<0.002–0.007	<0.002

* 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 2004a).

[†] Water quality data observed from three or less sampling occasions.

Microbiological contaminants

Microbiological testing of raw-water samples from the New Norcia borefield 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 count of less than 20 MPN (most probable number) per 100 mL sample is typically associated with low levels of faecal contamination and is used as a microbiological contamination benchmark of the raw water (WHO 2004). As such, counts less than 20 MPN are seen as indicating raw water that has not been recently contaminated with faecal material.

During the reviewed period, positive *E. coli* counts were recorded in less than two per cent of samples. This low occurrence of *E. coli* indicates minimal contamination of the groundwater from faecal sources.

Appendix B Photographs

Photo 1 Bore compound



Photo 2 Sheep grazing



Photo 3 Tagasaste plantation



List of shortened forms

ADWG	<i>Australian drinking water guidelines</i>
AHD	Australian height datum
ANZECC	Australian and New Zealand Environment Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
CA	catchment area
CFU	colony forming units
GL	gigalitre
HAZMAT	hazardous materials
kL	kilolitre
LEMC	local emergency management committee
mg/L	milligram per litre
mL	millilitre
ML	megalitre
NHMRC	National Health and Medical Research Council
NRMMC	Natural Resource Management Ministerial Council
NTU	nephelometric turbidity units
PSC 88	public sector circular number 88
PDWSA	public drinking water source area
TDS	total dissolved solids
TFSS	total filterable solids by summation
WHPZ	wellhead protection zone
WESTPLAN– HAZMAT	Western Australian plan for hazardous materials

Glossary

Abstraction	The pumping of groundwater from an aquifer, or the removal of water from a waterway or water body.
Adsorb	Adsorb means to accumulate on the surface of something. For example, micro-organisms can adsorb onto soil particles.
Australian drinking water guidelines	The <i>National water quality management strategy: Australian drinking water guidelines 6, 2004</i> (NHMRC & NRMMC 2004a) (ADWG) outlines acceptable criteria for the quality of drinking water in Australia (see this report's Bibliography).
Aesthetic guideline value	The concentration or measure of a water quality characteristic that is associated with acceptability of water to the consumer, e.g. appearance, taste and odour (NHMRC & NRMMC 2004a).
Australian height datum	Australian height datum is the height of land in metres above mean sea level. For example, the AHD is +0.026 m at Fremantle.
Allocation	The quantity of water that a licensee is permitted to be abstract is their allocation, usually specified in kilolitres per annum (kL/a).
Aquifer	An aquifer is a geological formation or group of formations able to receive, store and transmit significant quantities of water.
Bedrock	Solid unweathered rock lying beneath surface deposits of soil.
Bore	A bore is a narrow, lined hole drilled into the ground to monitor or draw groundwater (also see <i>well</i>).
Borefield	A group of bores to monitor or withdraw groundwater is referred to as a borefield (also see <i>wellfield</i>).
Colony forming units	Colony forming units are a measure of pathogen contamination in water.
Diffuse source	A diffuse source of pollution originates from a widespread non-specific area (e.g. urban stormwater runoff, agricultural infiltration) as opposed to a particular point source (see <i>point source pollution</i>).
Duty bore	The main bore used to supply water.
Effluent	Effluent is treated or untreated liquid, solid or gaseous waste discharged by a process such as through a septic tank and leach drain system.

Electrical conductivity	This estimates the volume of TDS or the total volume of dissolved ions in a solution (water) corrected to 25°C. Measurement units include millisiemens per metre and microsiemens per centimetre.
Eolian	Pertaining to or deposited by wind.
Fluviatile	Produced by river action.
Fractured rock	An aquifer where groundwater is present in the fractures, joints, solution cavities, bedding planes and zones of weathering igneous, metamorphic and deformed sedimentary rocks. Fractured rock aquifers are highly susceptible to contamination from land-use activities when aquifers crop-out or sub-crop close to the land surface.
Gigalitre	A gigalitre is equivalent to 1 000 000 000 litres or one million kilolitres.
Gneiss	A coarse-grained regional metamorphic rock that shows compositional banding and parallel alignment of minerals.
Granite	A coarse-grained, intrusive igneous rock composed of quartz, orthoclase feldspar, sodic plagioclase feldspar, and micas. Also sometimes a metamorphic product.
Hectare	A hectare is a measurement of area, equivalent to 10 000 square metres.
Health guideline value	Is the concentration or measure of a water quality characteristic that, based on current knowledge, does not result in any significant risk to the health of the consumer over a lifetime of consumption (NHMRC & NRMCC 2004a).
Hydrocarbons	A class of compounds containing only hydrogen and carbon, such as methane, ethylene, acetylene and benzene. Fossil fuels such as oil, petroleum and natural gas all contain hydrocarbons.
Hydrogeology	The study of groundwater, especially relating to the distribution of aquifers, groundwater flow and groundwater quality.
Leaching/leachate	The process by which materials such as organic matter and mineral salts are washed out of a layer of soil or dumped material by being dissolved or suspended in percolating rainwater. The material washed out is known as leachate. Leachate can pollute groundwater and waterways.
mg/L	A milligram per litre (0.001 grams per litre) is a measurement of a total dissolved solid in a solution.

Most probable number	Most probable number is a measure of microbiological contamination.
Nutrients	Minerals, particularly inorganic compounds of nitrogen (nitrate and ammonia) and phosphorous (phosphate) dissolved in water which provides nutrition (food) for plant growth.
Paleochannel	A remnant of a stream channel cut in older rock and filled by the sediments of younger overlying rock.
Pathogen	A disease-producing organism that can cause sickness and sometimes death through the consumption of water, including bacteria (such as <i>Escherichia coli</i>), protozoa (such as cryptosporidium and giardia) and viruses.
Pesticides	Collective name for a variety of insecticides, fungicides, herbicides, algicides, fumigants and rodenticides used to kill organisms.
pH	A logarithmic scale for expressing the acidity or alkalinity of a solution. A pH below seven indicates an acidic solution and above seven indicates an alkaline solution.
Point source pollution	Pollution originating from a specific localised source, e.g. sewage or effluent discharge; industrial waste discharge.
Pollution	Water pollution occurs when waste products or other substances (effluent, litter, refuse, sewage or contaminated runoff) change the physical, chemical or biological properties of the water, adversely affecting water quality, living species and beneficial uses.
Production bore	A bore used for the purpose of water supply.
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.
Public drinking water source area	Includes all underground water pollution control areas, catchment areas and water reserves constituted under the <i>Metropolitan Water Supply Sewerage and Drainage Act 1909 (WA)</i> and the <i>Country Areas Water Supply Act 1947 (WA)</i> .
Recharge	Recharge is the action of water infiltrating through the soil/ground to replenish an aquifer.

Recharge area	An area through which water from a groundwater catchment percolates to replenish (recharge) an aquifer. An unconfined aquifer is recharged by rainfall throughout its distribution. Confined aquifers are recharged in specific areas where water leaks from overlying aquifers, or where the aquifer rises to meet the surface.
Runoff	Water that flows over the surface from a catchment area, including streams.
Scheme supply	Water diverted from a source or sources by a water authority or private company and supplied through a distribution network to customers for urban and industrial use or for irrigation.
Semi-confined aquifer	A semi-confined 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.
Storage reservoir	A major reservoir of water created in a river valley by building a dam.
Tagasaste	A shrub of the Canary Islands that has bristle-tipped oblanceolate leaves; used as cattle fodder.
Total dissolved solids	Total dissolved solids consist of inorganic salts and small amounts of organic matter that are dissolved in water. Clay particles, colloidal iron and manganese oxides, and silica fine enough to pass through a 0.45 micrometer filter membrane, can also contribute to total dissolved solids. Total dissolved solids comprise sodium, potassium, calcium, magnesium, chloride, sulfate, bicarbonate, carbonate, silica, organic matter, fluoride, iron, manganese, nitrate (and nitrite) and phosphate (NHMRC & NRMCC 2004a).
Total filterable solids by summation	Total filterable solids by summation is a water quality test which is a total of the following ions: Na (sodium), K (potassium), Ca (calcium), Mg (magnesium), Cl equivalent (chloride), alkalinity equivalent, SO ₄ equivalent (sulfate) or S (sulfur) in grams, Fe (iron), Mn (manganese), and SiO ₂ (silicon oxide). It is used as a more accurate measure than total dissolved solids (TDS). The higher the value, the more solids that are present and generally the saltier the taste.
Treatment	Application of techniques such as settlement, filtration and chlorination to render water suitable for specific purposes, including drinking and discharge to the environment.
Turbidity	The cloudiness or haziness of water caused by the presence of fine suspended matter.

Unconfined aquifer	An aquifer in which the upper surface of water is lower than the top of the aquifer itself. The upper surface of the groundwater within the aquifer is called the watertable.
Wastewater	Water that has been used for some purpose and would normally be treated and discarded. Wastewater usually contains significant quantities of pollutant.
Water quality	Water quality is the collective term for the physical, aesthetic, chemical and biological properties of water.
Water reserve	A water reserve is an area proclaimed under the <i>Country Areas Water Supply Act 1947 (WA)</i> or the <i>Metropolitan Water Supply Sewerage and Drainage Act 1909 (WA)</i> for the purposes of protecting a drinking water supply.
Watertable	The upper saturated level of the unconfined groundwater is referred to as the watertable.
Wellfield	A wellfield is a group of bores located in the same area used to monitor or withdraw groundwater.
Wellhead	The top of a well (or bore) used to draw groundwater is referred to as a wellhead.
Wellhead protection zone	A wellhead protection zone (WHPZ) 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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