



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

Looking after all our water needs



Jurien Water Reserve drinking water source protection plan

Jurien town water supply



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

Important information

The *Jurien water reserve drinking water source protection plan* (2009, WRP no.109) was reviewed and updated in June 2011.

Please ensure you read the *Jurien water reserve drinking water source protection review* (2011, Revised WRP no.130) alongside the 2009 plan to obtain all of the information about this drinking water source.

The 2011 review reflects changes made to the 2009 proposed Jurien water reserve following consultation with the owners of land zoned as rural.

You can find the 2011 *Jurien water reserve drinking water source protection review* at www.water.wa.gov.au > publications > find a publication > drinking water source protection reviews or by contacting the Department of Water on +61 8 6364 7600 or drinkingwater@water.wa.gov.au.

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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 Jurien 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 these data, it accepts no responsibility 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 on +61 8 6364 7600 or send your enquiry to <drinkingwater@water.wa.gov.au>.

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Contents

| | |
|---|-----------|
| Contents | iii |
| Preface | v |
| Summary | vii |
| 1 Drinking water source overview | 1 |
| 1.1 Existing water supply system..... | 1 |
| 1.2 Water treatment..... | 1 |
| 1.3 Catchment details..... | 2 |
| 1.3.1 Physiography | 2 |
| 1.3.2 Climate..... | 3 |
| 1.3.3 Hydrogeology..... | 3 |
| 1.3.4 Groundwater occurrence | 5 |
| 1.4 Future water supply requirements | 6 |
| 1.5 Existing drinking-water source protection | 7 |
| 1.6 Department of Water management..... | 7 |
| 1.6.1 Current allocation licence..... | 7 |
| 2 Water quality monitoring and contamination risks | 13 |
| 2.1 Microbiological..... | 13 |
| 2.2 Health related | 14 |
| 2.3 Aesthetic..... | 14 |
| 2.4 Groundwater bores | 15 |
| 3 Land-use assessment | 17 |
| 3.1 Existing land uses and activities | 17 |
| 3.1.1 Reserves..... | 17 |
| 3.1.2 Private land..... | 18 |
| 3.1.3 Other uses | 19 |
| 3.1.4 Special control area | 20 |
| 3.2 Proposed land uses and activities | 20 |
| 4 Catchment protection strategy | 39 |
| 4.1 Protection objectives..... | 39 |
| 4.2 Proclaimed area..... | 39 |
| 4.3 Priority areas | 40 |
| 4.4 Protection zones..... | 41 |
| 4.5 Land-use planning | 43 |
| 4.6 Best management practices | 43 |
| 4.7 Surveillance and by-law enforcement..... | 44 |
| 4.8 Emergency response..... | 44 |
| 4.9 Implementation of this plan..... | 45 |
| 5 Recommendations | 47 |
| Appendices..... | 51 |
| List of shortened forms | 57 |
| Glossary | 59 |
| Bibliography..... | 65 |

Appendices

| | |
|-------------------------------------|----|
| Appendix A Water quality data | 51 |
| Appendix B Photographs | 55 |

Figures

| | |
|--|----|
| Figure 1 Existing Jurien Water Reserve locality map..... | 9 |
| Figure 2 Existing Jurien Water Reserve | 10 |
| Figure 3 Hydrogeological cross-section | 11 |
| Figure 4 Delineation of Water Reserve from groundwater modelling..... | 12 |
| Figure 5 Land use and activities in the Jurien Water Reserve | 22 |
| Figure 6 Proposed classification and protection zones for the Jurien Water Reserve | 42 |

Tables

| | |
|---|----|
| Table 1 Land use, potential water quality risks and recommended protection strategies | 23 |
|---|----|

Preface

This *Jurien Water Reserve drinking water source protection plan* amends the December 2008 protection plan previously published by the Department of Water. It reflects additional stakeholder consultation undertaken by the Minister for Water and letters sent by the Minister to land owners and the Shire of Dandaragan on 4 March 2009. It also reflects modified advice and recommendations in relation to abstraction bores and domestic livestock for any new subdivision proposals in the proposed Jurien Water Reserve.

This plan has been developed to help assess risks to water quality within the Jurien 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, good quality drinking water to consumers.

The *National water quality management strategy: Australian drinking water guidelines* recommend 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, the hazards and hazardous events that can compromise drinking water quality, and requires the development of preventative strategies and operational controls to ensure the safest possible water supply to consumers.

This plan details the location and boundary of the Jurien drinking water source, which provides potable water to the Jurien town water supply system. 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 guide state and local government land-use-planning decisions. It should be recognised in the *Shire of Dandaragan local planning scheme*, consistent with the Western Australian Planning Commission's Statement of planning policy: *Public drinking water source policy*. Other stakeholders should use this document as a guide for protecting the quality of water in the recommended Jurien Water Reserve.

This plan also acknowledges the *Conservation and Land Management Act 1984* statutory planning process, particularly in relation to those conservation reserves that fall within the proposed water reserve.

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

| Stages in development of a plan | | Comment |
|---------------------------------|---|---|
| 1 | Previous drinking water source protection plan document prepared. (1999) | Prepared after initial catchment survey and preliminary information gathering. |
| 2 | Conduct stakeholder consultation. (2007-2008) | Advice sought from key stakeholders using the previous protection plan document as a tool for information and discussion. |
| 3 | Prepare draft drinking water source protection plan. (2008) | Draft protection plan developed taking into account input from stakeholders and any additional advice. |
| 4 | Release draft drinking water source protection plan. (May-June 2008) | Draft protection plan released for a six-week public consultation period. |
| 5 | Publish drinking water source protection plan. (December 2008) | This protection plan was published after considering all submissions received on the draft plan. It included recommendations on how to protect water quality. |
| 6 | Publish finalised drinking water source protection plan. (December 2009) | This plan replaces the December 2008 published plan. It reflects the Minister for Water's decision to change some Priority 1 land within the proposed water reserve to Priority 2. Those decisions were reflected in a March 2009 media statement . Changes in this protection plan also reflect a new approach for the assessment of abstraction bores and domestic livestock issues in new subdivision proposals in P2 areas of the proposed Jurien Water Reserve. Proclamation of the proposed Jurien Water Reserve will now be considered based on the information in this finalised plan. |

Summary

Jurien, located 266 kilometres (km) north of Perth (Figure 1), obtains its water supply from a wellfield, 4 km north of the town. The borefield is comprised of three production bores drawing water from a shallow unconfined aquifer in the Tamala Limestone. Current licensed allocation is 420 000 kL; abstraction in 2006-07 was about 339 000 kL.

The existing wellfield is subject to a water source protection plan completed in 1999, but the water reserve (Figure 2) proposed in that document was never proclaimed. The Water Corporation nonetheless continues to undertake water quality monitoring and surveillance in that water reserve.

The Turquoise Coast Development, established by the Ardross Group of Companies, and other approved plans, are expected to increase the population of Jurien to more than 30 000. As a result a substantial increase in water supply (to 5.2 GL/a) and significant extension to the existing water supply system will be required.

Detailed drilling investigations undertaken by the Water Corporation in 2001 resulted in a better understanding of the hydrogeology and groundwater occurrence (Figure 3). They also determined an increased supply could be achieved by increasing the size of the existing Jurien wellfield (and as a consequence the existing water reserve), and (later) by adding bores to the existing Cervantes wellfield. Groundwater modelling has scientifically determined the extent of the expanded water reserve at Jurien required for the protection of this water source (Figure 4).

The intended allocation from the extended wellfield is 4.0 GL/a, an almost tenfold increase. As this increase had a potential impact on biodiversity in adjacent conservation reserves a detailed investigation was carried out into ecological impacts as part of the overall investigations by the Water Corporation. The steering group for this included local representation from the then Department of Conservation and Land Management as well as the then Department of Environment. Numerous workshops were attended by both departments.

Groundwater will be drawn from the Tamala Limestone and indirectly from the Lesueur Sandstone where there is upward discharge into the Tamala Limestone.

The proposed wellfield for the expanded Jurien Water Reserve will be located within the Drovers Cave National Park, while the northern part of the reserve is occupied by the Mt Lesueur National Park. These Parks and other conservation reserves are vested in the Conservation Commission of Western Australia and managed on their behalf by the Department of Environment and Conservation for the purpose of a national park, as defined in the *Conservation and Land Management Act 1984*. The eastern part of the reserve is occupied by private properties. Two large properties are located west of Cockleshell Gully Road, and three smaller properties are located east of Cockleshell Gully Road.

The balance of the water demand for the expanded water supply will be drawn from the existing Cervantes water reserve when demand reaches the 4.0 GL/a limit. This

could be at least 20 years in the future, and a new source protection plan for Cervantes will be drawn up at that time.

This plan proposes a water reserve be proclaimed to protect the quality of this water resource and reflect the priority areas and protection zones determined after the Minister for Water's ongoing consultation with stakeholders in early 2009 (Figure 6).

The proposed water reserve needs to be protected because the aquifer is shallow and at risk of contamination from above ground land uses. The following water quality protection measures are therefore proposed:

- All Crown land and Location 10599 (Lot 501) within the water reserve be recognised as Priority 1 to maximise the protection of water quality.
- The remaining parts of the water reserve, which includes all private land except Lot 501, be classified as Priority 2.
- Best management practices for water quality protection from current and future approved land uses in the water reserve should be implemented.
- Future applications for subdivision of rural land in Priority 2 areas should be assessed through the normal state and local government land use planning processes on the basis of:
 - a minimum lot size of 4 hectares in P2 areas for subdivisions in areas over limestone resources, and a 2 hectare minimum with an average of 4 hectares in other P2 areas;
 - alternative treatment units for each lot are to be required within P2 areas for new subdivision approvals;
 - new bores being assessed at the subdivision application stage against data that is available at the time. Additional hydrogeological data may be required by the Department of Water at this stage from the proponent to allow assessment of any new proposed bores;
 - vegetation clearing is to be prohibited for new subdivision approvals, only allowing for defined building blocks (including rain water tank storage), access ways and fencing; and
 - the carrying of livestock for commercial gain is to be prohibited for new subdivision approvals. An assessment of the carrying capacity of the land is required to demonstrate domestic livestock (e.g. pet horses) can be supported. Based on available data at the time of an application it may also be appropriate to further limit the total number of domestic livestock on lots to protect water quality and quantity.

It should be noted that the above measures do not prevent existing land uses in the proposed Jurien Water Reserve from continuing, such as farming, or appropriate land use planning and development (including subdivision) occurring consistent with the Shire of Dandaragan's local planning strategy. It should also be noted that based on advice from Landgate, and their assessment of similar situations in WA, there is no evidence to indicate that a P2 area in Jurien would have a measurable impact on the market value of those properties.

1 Drinking water source overview

1.1 Existing water supply system

The existing Jurien water supply scheme consists of a wellfield of three production bores (1/07 – replacing 1/75, 2/07 – replacing 2/75 and 2/00). The bores are spaced approximately 100 m apart in a northerly direction (Figure 2), and located about 4 km north east of the Jurien town site. These bores are shallow and screened between 8 to 12 metres below the ground level. The wellfield operates on a duty/stand-by basis (2 duty, 1 stand-by operation) with abstraction levels in 2006-07 of around 338,822 kilolitres. The wellfield, operated by the Water Corporation, is located within Reserve 29453 which is vested in the Minister for Water Resources.

The Ardross Group of Companies is developing the Turquoise Coast Development, a 9000 lot development south of Jurien. This landholding, of approximately 2000 ha, is bound by the Jurien town site to the north, the Hill River to the south, the Indian Ocean coastline to the west, and Indian Ocean Drive to the east. The expected population at full development could exceed 30000 people, with a development timeline in the order of 25 years. As a consequence of this development and predicted population growth in Jurien, a substantial increase in water supply is required, together with significant extensions to the existing water supply system.

Salinity in production bores has remained stable (between 720 and 818 mg/L Total Filtrated Soluble Salts) throughout the period of record. All chemical components of the reticulated supply meet the current Australian Drinking Water Guidelines (ADWG) (NHMRC & ARMCANZ, 1996).

1.2 Water treatment

The quality of the water from the existing Jurien bores is monitored in accordance with the program set out in the *Jurien Water Resource Management Operation Strategy* for Jurien Town Water Supply (Water Corporation, 2002).

Water from all of the currently operating bores has salinity levels in the upper range of the acceptable ADWG value. The aesthetic (non health related) guideline for hardness is exceeded in all of the bores due to dissolution of limestone. Calgon™ dosing mitigates elevated hardness levels prior to distribution. All other chemical and physical components are within the ADWG values. Details of typical water quality from the operating bores are shown in Appendix A.

The raw water is currently treated with chlorine (for disinfection), fluor (for fluoridation) and Calgon™ (to soften water) before being supplied to the town.

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, quality 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

Jurien is located about 266 km north of Perth and it is the largest of the towns in the Shire of Dandaragan (Figure 1). Jurien is primarily a fishing and holiday town but its importance as a recreational centre has been growing in recent years.

The proposed water reserve occupies two broad physiographic units – the Swan Coastal Plain and the Arrowsmith Region, which are separated by the Gingin Scarp. This boundary between these two units approximately follows the Cockleshell Gully Road.

The Swan Coastal Plain is a low-lying area covered by Quaternary coastal sediments and alluvium, west of the Gingin Scarp. In the area of the proposed water reserve the coastal plain is comprised of three northerly trending areas, roughly parallel to the coastline, which from west to east are the Quindalup Dune System, the Spearwood Dune System and the Bassendean Dune System.

The Quindalup Dune System is a narrow coastal dune system of stabilised and mobile dunes up to about 30 m high. They overlap the Spearwood Dune System which is comprised largely of lithified eolianite with leached quartz sand (Tamala Limestone). The Tamala Limestone commonly forms low hills, reaching up to 100 m in height, which follow the old dune topography. Within this system are locally well-developed cave systems. The Bassendean Dune System represents a belt of coastal dunes and shoreline deposits in a low-lying area between the Spearwood Dune System and the Gingin Scarp.

The soils in the Jurien area generally consist of leached white silica sand over yellow sand, and support hakea dryandra heath, with banksia woodland further inland.

East of the Cockleshell Gully Road, as the Gingin Scarp is crossed, the land of the Arrowsmith Region rises from 100 m to over 250 m in height. East of the scarp there are a range of soil types including sands containing lateritic gravel, duplex sand over clay subsoils and leached sands on valley floors. These soils support hakea dryandra heath, York gum and wandoo-marri Woodland in the uplands (Shire of Dandaragan, 1998).

The general Jurien area is drained by watercourses that originate in the Arrowsmith Region, but which terminate (apart from the Hill River to the south of the proposed

reserve) in swamps and lakes in interdunal depressions in the western half of the Swan Coastal Plain.

1.3.2 Climate

The region has a Mediterranean-type climate characterised by hot, dry summers and mild, wet winters. Rainfall decreases eastwards across the Swan Coastal Plain to the Arrowsmith Region. The Jurien region experiences a long term (39 years) average rainfall of about 542 mm per annum (Bureau of Meteorology 2002). The average annual evaporation as measured at Badgingarra further inland is 1662 mm, indicating a considerable rainfall deficit.

However, since 2000 the area has received considerably reduced rainfall with only one year exceeding the 39 year average. Over the last eight years the average rainfall has been 444 mm, an 18% reduction. Such a significant rainfall decrease warrants stronger controls on protection of this groundwater resource.

1.3.3 Hydrogeology

The area around and beneath the proposed water reserve has been intensively investigated. Regional investigations of the hydrogeology and groundwater resources were undertaken by the Geological Survey of Western Australia, (Harley 1974, Kern 1993), and the Water and Rivers Commission (Kern 1997) while the Water Corporation investigated the area north of Cervantes (Baddock 1997) for the Cervantes town water supply.

In 2001 the Water Corporation (Baddock et al 2002a, 2002b) carried out an intensive regional investigation around the Jurien–Cervantes area to determine the possibility of obtaining a substantially increased supply for the Jurien town water supply. This increase was to meet the projected demands for a large regional development at Jurien by Ardross Estates Pty Ltd.

The review of the hydrogeology of the area, as detailed in this plan, is based on these investigations.

The Jurien area is located in the northern part of the Perth Basin. Within and around the proposed water reserve the area is underlain by superficial formations of Quaternary age, which in turn overlies shales and sandstones of Mesozoic age.

The *superficial sediments* occur on the Swan Coastal Plain and comprise the Safety Bay Sand, the Tamala Limestone, the Bassendean Sand and the Guildford Formation. The Safety Bay Sand occurs to the west of the proposed water reserve and within the Jurien town site, and overlies the Tamala Limestone.

The Tamala Limestone, the main superficial aquifer, occurs adjacent to the coast and extends to about 14 km inland and beneath the western part of the water reserve, forming a distinctive ridge up to 120 m in height. The limestone crops out extensively

on the ridge and along the coastal strip. It is karstic and well fractured and has numerous cavities particularly at the water table. It has a maximum thickness of up to 55 m to the south of the water reserve. Existing production bores have been drilled into this formation.

To the east, the Tamala Limestone interfingers with the Bassendean Sand which is fine- to medium-grained quartz sand. It has a maximum thickness of 31 m in the middle of the water reserve on the boundary between Location 10598 and Reserve R31302. The Bassendean Sand has a high leaching capacity and inappropriate land uses, such as the development of horticulture, within this area would increase the potential for nutrient discharge and infiltration of pathogens to the underlying aquifer(s). Elsewhere in the Perth Basin, where horticulture has been established upstream of an existing water supply (for example Woodridge) on similar soils, contamination of the water supply by nutrients has resulted in the water source becoming unusable.

The Bassendean Precinct Special Control Area (BPSCA) was assigned over this area to limit such developments, and to minimise the risk to water supply. However in December 2007, the Shire of Dandaragan commenced the process to remove the BPSCA from the Shire's Local Planning Scheme No. 7 (2001). If it is removed, the wellfield, the future water supply to Jurien, and indirectly the town's development, will be at risk.

The Guildford Formation underlies the Bassendean Sand beneath the eastern part of the Swan Coastal Plain, and is essentially a clayey sand becoming more clayey towards the Gingin Scarp. While it is present beneath the Bassendean Sand in the eastern part of the proposed water reserve it does not form an impermeable base to the superficial sediments (Kern 1997). Groundwater in the Bassendean Sand, while mostly flowing to the west towards the Tamala Limestone and the wellfield, will also provide recharge through to the underlying Mesozoic aquifer from slow leakage.

The *Mesozoic sediments* underlying the superficial sediments within the proposed water reserve are comprised of the Kockatea Shale, the Lesueur Sandstone and the Cattamarra Coal Measures. Controlling the distribution of these formations, and the occurrence and direction of groundwater flow within them, are two major fault systems – the Beagle Fault at the western edge of the water reserve and the Lesueur Fault at the eastern edge of the reserve.

The Kockatea Shale underlies the Tamala Limestone in the western part of the reserve and is bounded to the east by the Beagle Fault. Because of its high shale content it forms an aquiclude and acts as a boundary to westward groundwater flow (Kern op. cit.).

The Lesueur Sandstone occurs between the two fault systems, extending from east of the western boundary of the reserve to east of the eastern boundary of the reserve, where it abuts the Lesueur Fault. The Lesueur Sandstone is medium- to

very coarse-grained quartz sandstone with minor siltstone and conglomerate. The full thickness was not penetrated during the investigation drilling.

The Cattamarra Coal Measures occur east of the Lesueur Fault and consists of sandstone with interbeds of siltstone, claystone, carbonaceous shale and coal.

1.3.4 Groundwater occurrence

The major aquifers within the proposed water reserve are the superficial Tamala Limestone and the Mesozoic Lesueur Sandstone. Figure 3 is a cross-section through the aquifer along the Jurien Bay Road and depicts the groundwater flow system.

Groundwater in the Tamala Limestone is derived from:

- direct recharge from rainfall on the limestone
- lateral flow from the east from the Bassendean Sand
- runoff from laterite capped areas in the east on the Bassendean Sand
- the Nambung River where it enters caves near the coast.

The Tamala Limestone also receives recharge from upward leakage from westerly flowing groundwater in the Lesueur Sandstone immediately east of the Beagle Fault.

Recharge to the Lesueur Sandstone occurs from direct rainfall east of Cockleshell Gully Road on the Gingin Scarp, and from slow leakage through the superficial sediments in the eastern part of the proposed water reserve.

The depth to the water table in the Jurien area ranges from 3 to 8 m below ground level near the existing and proposed wellfields. The depth to the water table varies with surface topography with depths in the order of 10 to 40 m in elevated areas.

Groundwater flow in the Tamala Limestone is generally westerly towards the ocean. Flow in the underlying Lesueur Sandstone is south-westerly from the main recharge area on the Gingin Scarp, towards the Beagle Fault where upward heads indicate direct leakage upwards into the Tamala Limestone.

Salinity in the Tamala Limestone ranges from 395 to 973 mg/L TDS and in the Lesueur Sandstone from 336 to 635 mg/L TDS within the proposed water reserve.

Discharge of the groundwater is to the ocean. The groundwater is generally brackish adjacent to the coast where there is a saltwater interface.

The superficial aquifer is shallow and unconfined, and is therefore considered to be highly vulnerable to contamination. This was recognised with the development of the Bassendean Precinct SCA. While the Lesueur Sandstone is also vulnerable to contamination where it is recharged, it is also vulnerable from inappropriate developments within the Bassendean Sand and from downward leakage from the sand through the Guildford Clay.

1.4 Future water supply requirements

As a result of future expectations of increased urban development within and around Jurien, mostly resulting from the Ardross Estates development, it is estimated that the population of Jurien will increase by some 30 000 people. The ultimate development of the Ardross project is expected to require an additional 9600 to 13 300 water services.

The investigations carried out in 2001 by the Water Corporation looked at several wellfield scenarios with detailed groundwater modelling to determine the optimal supply in regards to both quantity and quality. The investigations determined that the optimum wellfield development would be by expansion of the existing wellfield to the north along the old stock route north of bore 2/07. The model enabled the determination of the extent of the new water reserve by delineating the flow paths to the bores under the recommended pumping regimes (Figure 4).

To meet the estimated total demand of the Turquoise Coast developments the extension of the existing Jurien wellfield would eventually consist of 17 production bores and 1 stand-by bore capable of producing up to 4.0 GL/annum. At some time in the future, when the water demand approaches its peak, there will be a need for up to 4 additional bores (3 production, 1 stand-by) to be drilled in the existing Cervantes Water Reserve (in the existing Priority 1 area) to produce up to 1.2 GL/annum to supply the southern extensions of the Ardross development at Jurien (Baddock et al 2002a, 2002b).

It is proposed that the existing Jurien supply and distribution system be initially expanded to supply the existing township, plus the first 300 services of the Turquoise Coast development south of Jurien. The annual demands for this system will be 700 ML/year and 6.0 ML/day Average Daily Peak Week demand. This expansion would require an immediate two new bores (assumed production rate of 2.0 ML/day), and an upgrade of existing water treatment systems to meet increased flows. Additional bores will be established as required to meet the ultimate demand of about 5.1 GL/annum.

Water from the Jurien wellfield would be pumped to a storage tank near the current chlorinator injection point and treated to meet the ADWG, and then pumped eventually to a 70ML (2 x 35 ML) central reservoir. Water from the southern wellfield would be collected in a 1000kL storage tank, treated to the required standard and then pumped to the central storage reservoir.

Although the complete scheme will include the bores in the Cervantes Water Reserve, this current plan will focus only on the extension to the existing Jurien Water Reserve. Any further requirements for protection of the southern bores will be dealt with in a review of the Cervantes source protection plan at the appropriate time.

1.5 Existing drinking-water source protection

A Water Source Protection Plan was developed for the original Jurien wellfield in 1999 by the Water and Rivers Commission (now the Department of Water) (Water and Rivers Commission 1999a). The boundaries of this reserve were based on cadastral data only, due to a lack of hydrogeological information that would allow appropriate modelling of the reserve boundaries. However the water reserve delineated in this plan was never proclaimed under the *Country Areas Water Supply Act 1947*.

The Water Corporation maintains fencing around the bores and signage on the bore compound is present. However, there is currently no source protection signage throughout the water reserve proposed in the 1999 protection plan.

The bores proposed for the southern wellfield will be located within the current Cervantes Water Reserve (Water and Rivers Commission 1999b) for which a source protection plan exists, and for which the identified water reserve has been gazetted under the *Country Areas Water Supply Act 1947*.

The Jurien Groundwater Area was proclaimed in 1990 under the *Rights in Water and Irrigation Act 1914* (RIWI Act) to allocate surface water and ground water resources within its boundaries and to manage its sustainable use.

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 RIWI Act. Under the Act, the right to use and control surface and groundwater is vested with the Crown. This Act requires licensing of groundwater abstraction (pumping water from a bore, spring or soak) within proclaimed groundwater areas.

Both the existing and proposed water reserves are located in the proclaimed Jurien Groundwater Area. The Water Corporation is currently licensed to draw 420 000 kL/annum from the Jurien wellfield for public water supply purposes in accordance with Groundwater Well Licence 62152 (2). The number of domestic services supplied in 2006-07 was 932 (Water Corporation 2007).

The abstraction of groundwater under this licence is undertaken in accordance with the Jurien Water Resource Management Operation Strategy approved by the Department of Water.

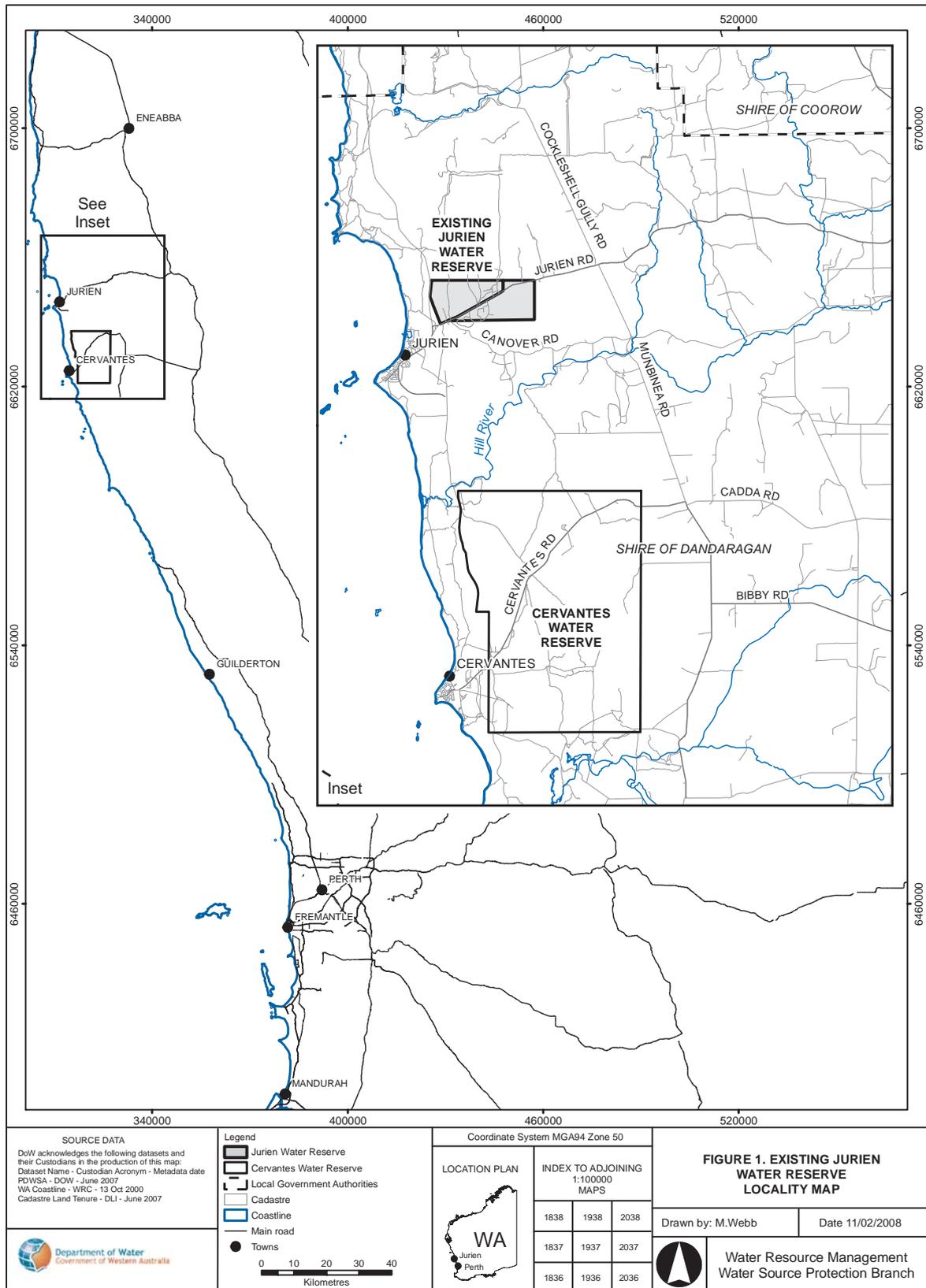


Figure 1 Existing Jurien Water Reserve locality map

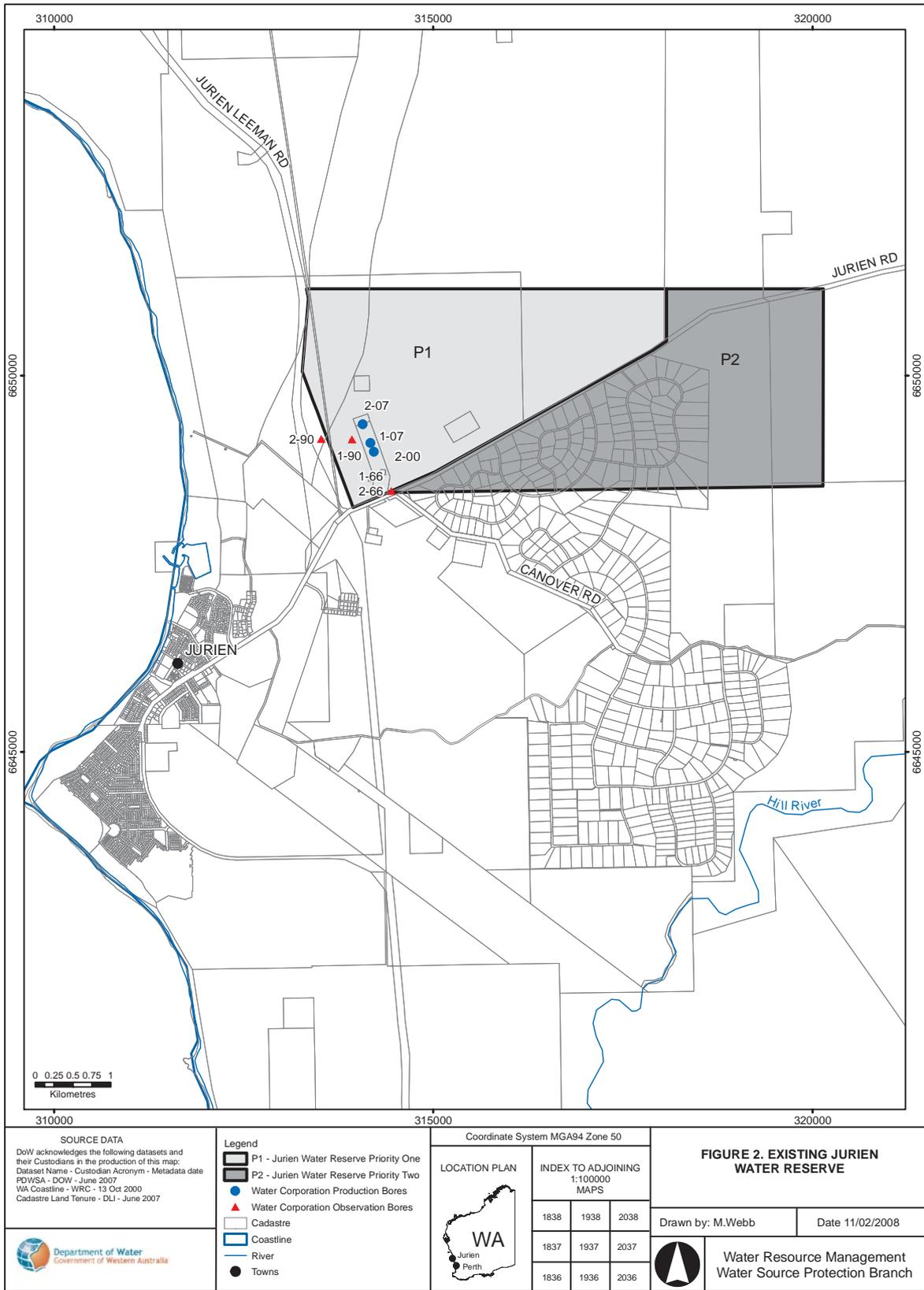


Figure 2 Existing Jurien Water Reserve

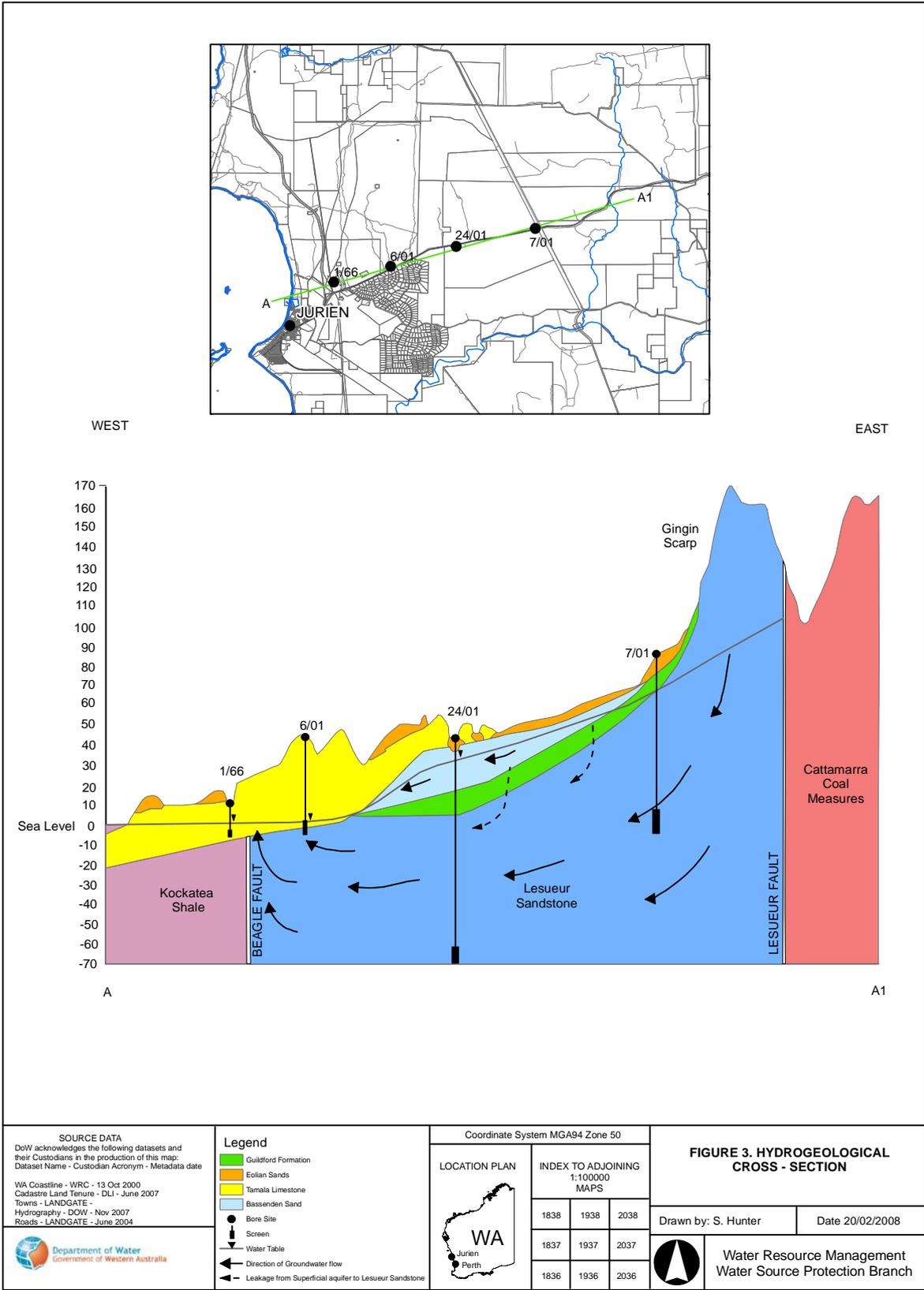


Figure 3 Hydrogeological cross-section

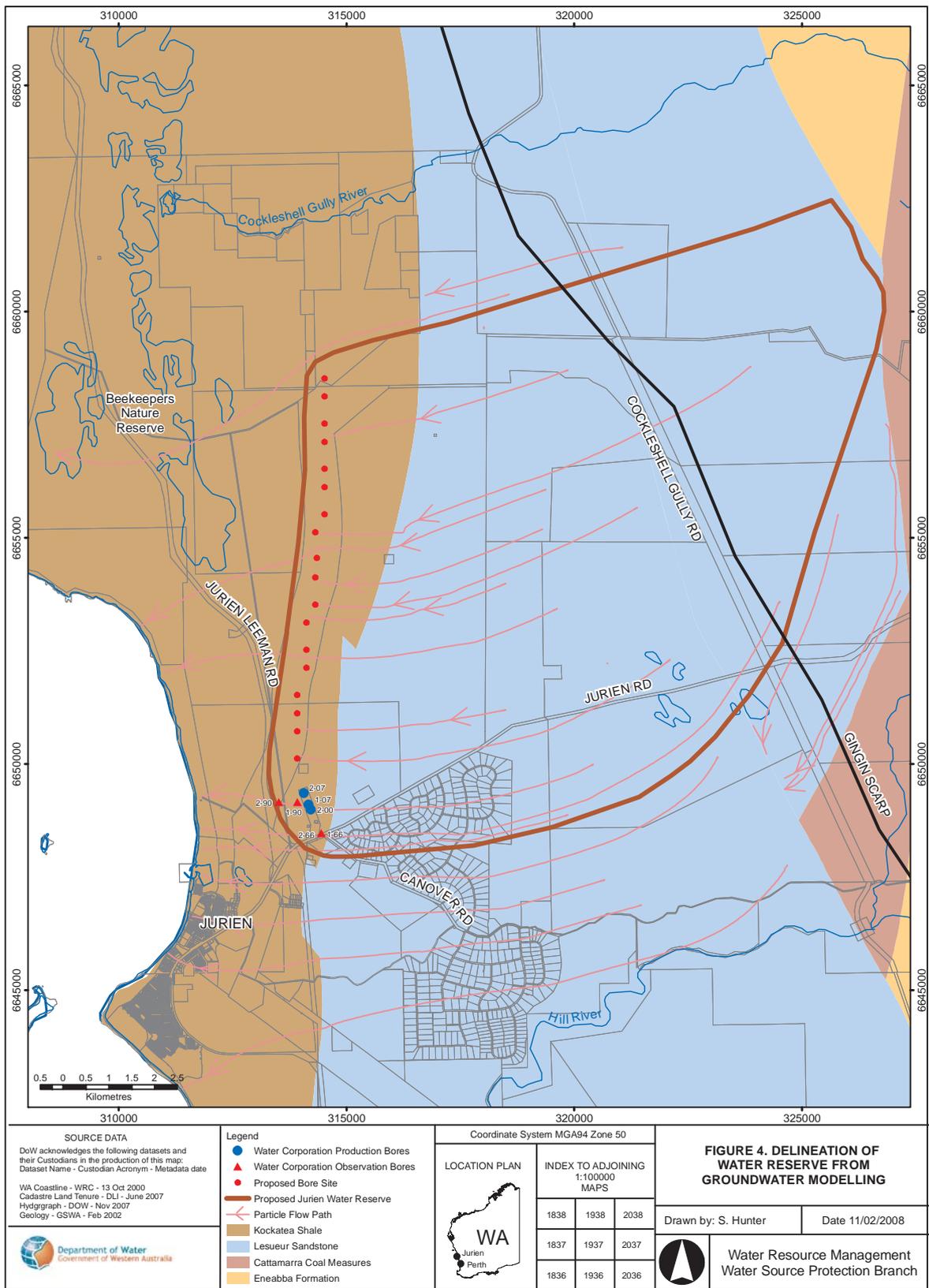


Figure 4 Delineation of Water Reserve from groundwater modelling

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 a reliable, safe, quality, aesthetically-acceptable drinking water to consumers.

The Water Corporation regularly monitors the quality of raw water from the Jurien Water Reserve for microbiological, health-related and aesthetic (non-health-related) characteristics, in accordance with the ADWG. The monitoring results of water supplied to consumers are reviewed by an intergovernmental committee called the Advisory Committee for the Purity of Water that is chaired by the Department of Health.

A water quality summary for the Jurien town water supply from 1998 to 2003 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 Water > Water quality > Latest report > Drinking water quality annual report.

Contamination risks relevant to the Jurien Water Reserve are described below. The most significant risks to water quality in Jurien are risks from septic tanks (Alta Mare Estate), pastoral grazing, hydrocarbon contamination from transportation, storage and use of fuels, and pesticides from cropping activities.

2.1 Microbiological

Pathogens are types of micro-organisms that are capable of causing diseases. These 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).

There are a number of pathogens that are commonly known to contaminate water supplies worldwide. These include bacteria (e.g. salmonella, *Escherichia coli* and cholera), protozoa (for example, cryptosporidium, giardia) and viruses. *Escherichia coli* counts are a way of measuring these pathogens and are an indicator of faecal contamination.

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).

The effect on people consuming drinking water that is contaminated with pathogens varies 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 *Escherichia coli* and campylobacter (NHMRC & NRMCC 2004b). Preventing the introduction of pathogens into the water source 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, prompt notification of relevant authorities and clean up of the spill are required.

Drinking water supplies can be contaminated by nutrients such as nitrogen as a result of leaching from fertiliser application, 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).

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

2.3 Aesthetic

Impurities in drinking water can affect the aesthetic qualities of water such as its appearance, taste, smell and feel. Such impurities are not necessarily hazardous to human health; for example, water that is cloudy and has a distinctive odour or has 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). Hardness and salinity at Jurien are slightly above the ADWG aesthetic guidelines. Hardness is treated by CalgonTM to reduce levels.

2.4 Groundwater bores

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

Drinking water bores are operated in the Jurien Water Reserve by the Water Corporation. If bores for other purposes (i.e. irrigation, private household use) are drilled near to 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 RIWI Act. All bores should be constructed in accordance with *Minimum construction requirements for water bores in Australia* (National Minimum Bore Specifications Committee 2003).

Similarly any private bores drilled and extracting water from within the proposed water reserve will have the potential to reduce the availability of water to the wellfield.

It is recommended that new bores proposed for subdivision applications/approvals are properly assessed to ensure they will not have a negative impact on water quality or quantity in the proposed Jurien Water Reserve. The assessment/approval of bores, or other means of meeting water supply requirements, should be undertaken as part of the land use planning decision making process for subdivisions. There should be no expectation that water of sufficient volume or quality is available to meet the needs of new subdivisions. This matter should be investigated before the subdivision process progresses too far.

These above recommendations are important given the reduced rainfall for the Jurien area over the last few years, and the projected effect of a drying climate associated with global warming.

Any exploration bores that may be approved for drilling by the Department of Water will need to be backfilled and sealed in an approved manner, to avoid any risk in inducing a rapid pathway for contamination to the aquifer.

It is also noted that some private bores within the proposed water reserve may be drilled beneath the superficial sediments and into the Lesueur Sandstone. The owners of any existing bores identified as penetrating the Lesueur Sandstone should be advised of the requirements for licensing within this aquifer. Any new bores that are proposed to be drilled into this deeper aquifer will first require assessment and approval from the Department of Water.

3 Land-use assessment

3.1 Existing land uses and activities

The current Jurien borefield is located within Reserve 29453, which is vested in the Minister for Water Resources for water supply purposes. This reserve is surrounded by a larger reserve, Reserve 18865, which is exempt from sale and controlled by the Department of Land Administration. These reserves are primarily covered with undisturbed native vegetation (Appendix B, Photograph 1).

There are a range of existing land uses and activities within the proposed water reserve. These include:

- National Parks and Conservation Reserves
- Rural Subdivisions
- Agriculture
- Public Purposes (landfill, roads and tracks)
- Recreation
- Industry and Commercial.

The existing land uses and locations are shown in Figure 5. Existing and potential future land uses, potential water quality risks and recommended strategies are detailed in Table 1.

3.1.1 Reserves

The National Parks and Conservation Reserves are vested in the Conservation Commission of Western Australia and managed by the Department of Environment and Conservation (DEC) under the *Conservation and Land Management Act 1984*.

Drovers Cave National Park (Reserve 31302) encroaches on the north eastern side of Jurien Road and extends to the northern boundary of the proposed reserve. This area is mostly covered by undisturbed native vegetation. Several natural caves are located within the National Park namely, Moorba Cave, Old River Cave, Mystery Cave, Hasting Cave and Drovers Cave. General access to the caves is restricted by the presence of a locked gate at the entrances. Access to the National Park is limited to four wheel drive vehicles and there are no formal facilities for picnicking or camping.

The northern part of the water reserve extends into the Mt Lesueur National Park (Reserve 42032) and a small reserve 35593 designated for Restoration and Conservation. These areas are also mostly covered by undisturbed native vegetation.

A Conservation Park (Reserve 48717) is located within a portion of the southern area of the water reserve, south of Jurien Road and east the adjacent Alta Mare rural residential subdivision. The conservation park extends southwards beyond the water reserve boundary. The area is mostly covered by undisturbed native vegetation.

West of the proposed reserve, and down-gradient of groundwater flow to the wellfield, is the Beekeepers National Park (North) – Reserve 24496 – managed on behalf of the Conservation Commission by DEC.

The management strategies for these reserves are outlined in the *Management plan for Lesueur National Park and Coomallo Nature Reserve* (1995), produced by the Department of Conservation and Land Management (now known as DEC). This document covers issues such as recreation, conservation and land management within and surrounding the reserves.

Unauthorised recreation

The DEC have recently opened new visitor and recreational facilities within an area of the Lesueur National Park located, in part, within the proposed water reserve. The park area, to the north east of the water reserve has day use facilities including picnic areas, walk trails, interpretive signage and toilet facilities. The area is accessed via a 18.5 km one-way bitumen road from Cockleshell Gully Road.

There is some unauthorised recreation throughout the National Park and conservation reserve areas primarily from off road bikes.

3.1.2 Private land

Rural subdivision

The north-west part of Location 10602 is zoned rural residential and within the water reserve area is occupied by rural residential blocks ranging in size from 2 ha to in excess of 23 ha, which form the Alta Mare Subdivision.

The original water source protection plan (1999) recommended that strict limitations be placed on lot sizes, the keeping of livestock, and land use activities, and required the installation of recognised on-site effluent disposal systems to minimise potential contamination risks.

The degree to which these controls have been adopted is outlined in the Shire of Dandaragan Local Planning Scheme No. 7 (2001). The Scheme specifies that the rural residential zoning provides rural lots of a size generally between 2.0 ha and 20.0 ha for residential purposes. For this zoning, the Scheme restricts the keeping of livestock for commercial purposes and discourages, but will allow in some cases, the keeping of livestock for domestic purposes. The scheme delegates the setting of specifications for on-site effluent disposal systems to the local authority, i.e. the Shire, and states that non-standard systems may be required.

Agriculture

Locations 10600 and 10599 are privately owned and used for extensive agriculture, mainly grazing. The extended wellfield also lies down gradient of Location 10598, and the proposed water reserve extends to incorporate the western parts of Locations 10413, 10414, and 10415. These locations are also privately owned and currently used for cattle grazing and some tagasaste cropping. There are areas of undisturbed native vegetation on some of these locations. The north-west corner of the proposed reserve encroaches on to Locations 828 and 9541, which are currently mostly covered with native vegetation.

3.1.3 Other uses

Roads and tracks

Jurien Road is the main access road to Jurien Bay from the Brand Highway. This road bisects the southern portion of the water reserve for approximately 11 km between Cockleshell Gully Road and Indian Ocean Drive.

Cockleshell Gully Road bisects the eastern portion of the water reserve in a northerly direction for approximately 8 km. This road is currently unsealed. Several small tracks also access the reserve area from Jurien and Cockleshell Gully Roads.

Landfill

Immediately north of the existing wellfield is Reserve 25471 which is classified for the purpose of a 'sanitary site and rubbish disposal'. It is located close to bore 2/75 and 2/07, and would be in the recharge area of future drinking water supply bores. The site is not currently being used and is not required for future rubbish disposal by the Shire of Dandaragan. The Shire of Dandaragan Local Planning Scheme No. 7 identifies Reserve 25471 as a Public Purpose—school.

Commerce and industry

Reserve 35190 (on Victoria Location 11231) located to the south of Jurien Road (in the south west corner of the water reserve) is vested with the Shire of Dandaragan for limestone extraction. There is an existing pit located on this reserve.

A portion of Reserve 18865 (Lot 12320) is also currently being used for sand or limestone extraction.

Location 10600 is owned by Ardross Estates and is considered a potential future airport site by its owners. However, the land is currently zoned rural and existing land use is consistent with this.

3.1.4 Special control area

A Special Control Area (the Bassendean Precinct Special Control Area) exists over the eastern part of the reserve in recognition of the high leaching potential of the surface soils and sands. This area has the potential to be contaminated from inappropriate land use activities and the excessive addition of fertiliser and pesticides/herbicides. A move to delete the Special Control Area from Local Planning Scheme No. 7 was commenced by the Shire of Dandaragan in December 2007 contrary to advice provided by the Department of Water. While its deletion is supported by the Shire, it still has to be approved by the Environmental Protection Authority, the Department of Planning, and the relevant Ministers.

3.2 Proposed land uses and activities

Future development proposals near Jurien and in particular within the proposed Jurien Water Reserve, need to be considered and based on pro-active drinking water source protection, with sustainable water use planning being considered concurrently and as a key part of statutory land use plans.

Consequently the Shire of Dandaragan's Local Planning Scheme will need to recognise the proposed water reserve, priority classification areas and the management principles as set out in this plan.

The statutory management planning processes applicable under the *Conservation and Land Management Act 1984* are also noted. It is incumbent on the DEC to ensure that any planning being undertaken for the conservation reserves within the proposed water reserve are referred to the Department of Water so that they can be incorporated into the ongoing monitoring and surveillance requirements of this plan.

Any proposals to change or intensify the current land use practices in the Jurien water reserve that are inconsistent with the Water quality protection note *Land use compatibility in public drinking water source areas* (Department of Water) should be referred to the Department of Water for comment. The department will provide advice and make recommendations appropriate these proposals.

In particular, some consideration is being given to the use of Location 10600 for an airport site. This is illustrated in the Ardross Plan for the Beachridge development, however the land is currently zoned rural in the Shire of Dandaragan's Local Planning Scheme No. 7. This land use is incompatible with a P1 or P2 classification, assuming an airport comes under the 'Service Station' category in the model scheme text. Therefore it is unlikely that this land use would be supported by the Department of Water.

Some large tracts of private land exist within the proposed water reserve. There is therefore the potential for this land to be considered for rezoning to allow the

development of rural residential properties due to this land being close to the Jurien town site.

Based on further discussions with stakeholders in early 2009, the Minister for Water determined that in addition to a change in the priority classification of most private land in the water reserve to P2, he also confirmed discussions between the Department of Water and Shire of Dandaragan that allowed for the subdivision of rural land within P2 areas down to a minimum lot size of 4 hectares in areas over limestone resources and a 2 hectare minimum with an average of 4 hectares for all other P2 areas.

Other measures expected to be achieved for subdivision of rural land (consistent with the above mentioned lot size criteria) within P2 areas are:

- alternative treatment units for each lot are to be required within P2 areas for new subdivision approvals;
- new bores being assessed at the subdivision application stage against data that is available at that time. Additional hydrogeological data may be required by the Department of Water at this stage from the proponent to allow assessment of any proposed new bores;
- vegetation clearing is to be prohibited for new subdivision approvals, only allowing for defined building blocks (including rain water tank storage), access ways and fencing; and
- the carrying of livestock for commercial gain is to be prohibited for subdivision approvals. An assessment of the carrying capacity of the land is required to demonstrate domestic livestock (e.g. pet horses) can be supported. Based on available data at the time of an application, it may also be appropriate to further limit the total number of domestic livestock on lots to protect water quality and quantity.

It should be noted that the above measures do not prevent existing land uses in the proposed Jurien Water Reserve from continuing, such as farming, or appropriate land use planning and development (including subdivisions) occurring consistent with the Shire Dandaragan's local planning strategy.

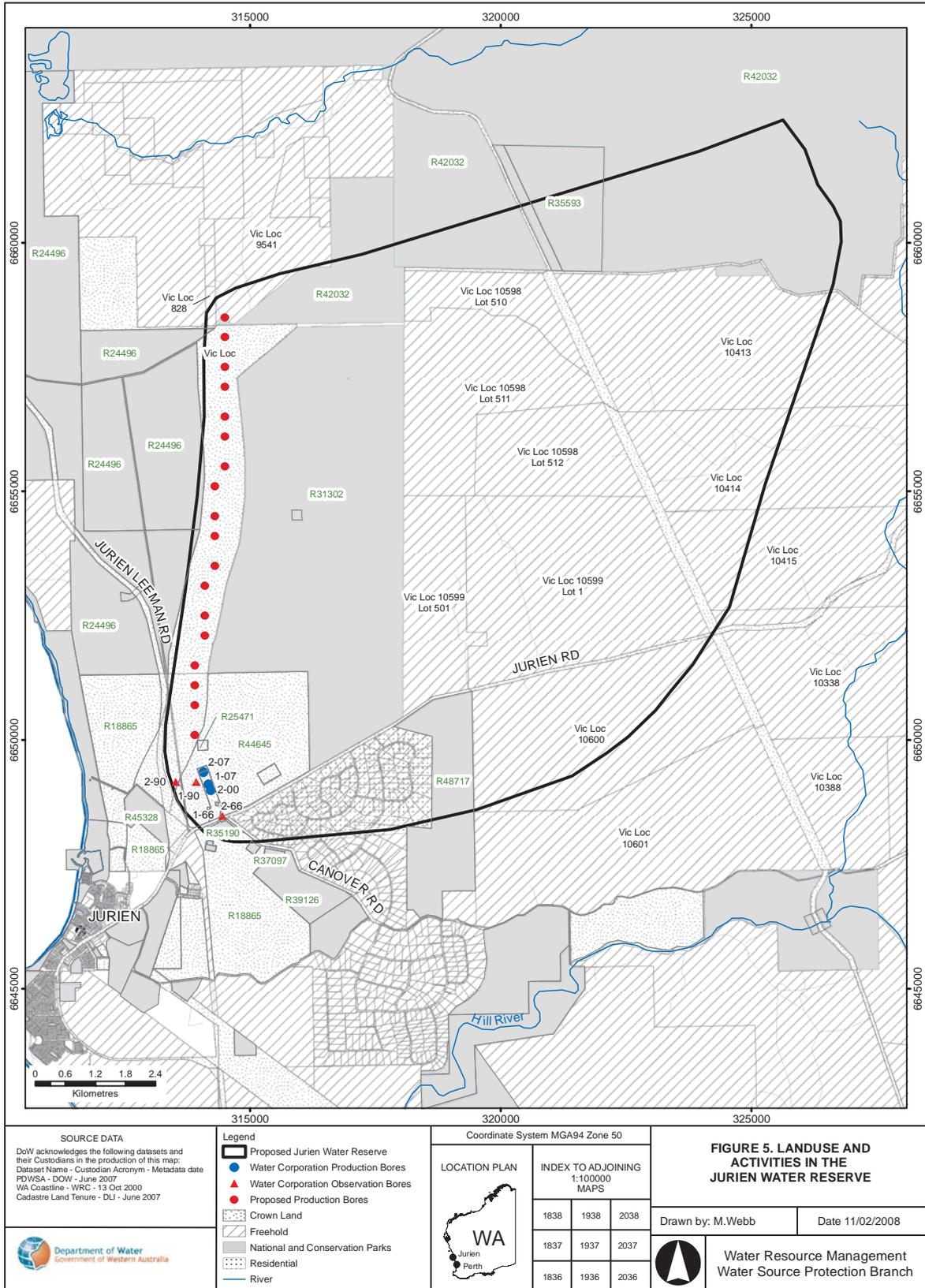


Figure 5 Land use and activities in the Jurien Water Reserve

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 | | | |
| Crown land (existing and proposed water reserve) | | | | | |
| Tracks <ul style="list-style-type: none"> • wellfield access • other | Hydrocarbons and chemicals from spills Pathogens from litter | Low Low | <ul style="list-style-type: none"> • Limited number of tracks • Usually dense vegetation. | <ul style="list-style-type: none"> • Locked gate and signage at entrance to wellfield. • Chlorination. • DEC manages and maintains fire access tracks in the Conservation estate. | <ul style="list-style-type: none"> • Best practice management – see Water quality protection note (WQPN) <i>Tracks and trails near sensitive water resources</i>. • DEC management – road closures. |
| <ul style="list-style-type: none"> • Apiarists • Wildflower picking • Seed collection | <ul style="list-style-type: none"> • Pathogens from human activity | Low | <ul style="list-style-type: none"> • Little activity is reported. • Main concern from these activities is the potential for people to be within the water reserve. | <ul style="list-style-type: none"> • Permits required from DEC which manages these activities. • Chlorination. • Catchment surveillance. | <ul style="list-style-type: none"> • Supported activity with controls, but not in wellhead protection zones (WHPZ). • Continuation of water quality monitoring and surveillance program. |

| Land use/activity | Potential water quality risks | | Consideration for management | Current preventative measures | Recommended protection strategies |
|-------------------|---|---------------------|---|--|--|
| | Hazard | Management priority | | | |
| Roads (sealed) | Hydrocarbons and chemicals from spills Pathogens from litter Herbicides from weed control | Low Low Low | <ul style="list-style-type: none"> • Bulk haulage on roads in the area is mainly associated with servicing farms i.e. haulage of grain, fertiliser and chemicals. • The bores are located up-slope and approximately 50m from an unsealed rural access road. • Accidents/spills are rare. • The Local Emergency Management Committee (LEMC) responds to incidents. • Roads managed by the Shire of Dandaragan – use of DoH Circular PSC 88: <i>Use of Herbicides in water catchment areas</i> (PSC 88) provides guidance for herbicides in PDWSAs. | <ul style="list-style-type: none"> • Water quality monitoring. • Sealed bores and fenced compound. • Chlorination. • Signage – at wellfield and Jurien Groundwater Area. • LEMC response. | <ul style="list-style-type: none"> • Best practice management as recommended in <i>WQPN Roads near sensitive water resources</i>. • Continuation of water quality monitoring and surveillance program. • Use of PSC88 to guide herbicide use. |

| Land use/activity | Potential water quality risks | | Consideration for management | Current preventative measures | Recommended protection strategies |
|--|--|---------------------|--|---|--|
| | Hazard | Management priority | | | |
| Off-road vehicle use | Hydrocarbons and chemicals from spills Pathogens from litter and human activity | Low Low | <ul style="list-style-type: none"> Limited number of tracks. Little activity reported. | <ul style="list-style-type: none"> Locked gate and signage at entrance to wellfield. Monitoring and surveillance by Water Corporation (WC). | <p><i>Unauthorised vehicle use is not an acceptable activity within a water reserve or WHPZ.</i></p> <ul style="list-style-type: none"> Further signage to access roads and catchment boundaries as approved. |
| Illegal hunting | Pathogens from human and animal activity (litter, carcasses etc.) | High | <ul style="list-style-type: none"> Little activity is reported. | <ul style="list-style-type: none"> WC and DEC surveillance. Chlorination. | <p><i>Hunting is not an acceptable activity in the water reserve</i></p> <ul style="list-style-type: none"> Further signage to access roads and reserve boundary as approved. |
| Illegal activities <ul style="list-style-type: none"> drug growing wildflower picking (no permit) seed collection | Pathogens from human and animal activity Fertiliser application | Low Medium | <ul style="list-style-type: none"> Little activity is reported. Illegal activity could increase with ease of access. | <ul style="list-style-type: none"> WC and DEC surveillance. Chlorination. | <p><i>These illegal activities are not acceptable in the water reserve.</i></p> <ul style="list-style-type: none"> Permits required from DEC for wildflower picking and seed collection. |

| Land use/activity | Potential water quality risks | | Consideration for management | Current preventative measures | Recommended protection strategies |
|-------------------|--|---------------------|---|--|--|
| | Hazard | Management priority | | | |
| Fire management | Increased turbidity in recharging surface waters | Low | <ul style="list-style-type: none"> • Fire management through fire pre-suppression and suppression. • Fuel reduction burning is an established essential land management practice, but should be managed to reduce risk to wellfield infrastructure. | <ul style="list-style-type: none"> • Fire management controls by experienced DEC officers. • State Wildfire Emergency Management Plan. • Burn prescriptions for DEC managed land give consideration to water quality protection in the pre-burn prescription and during implementation. | <p><i>Acceptable activity with best management practices</i></p> <ul style="list-style-type: none"> • Continued DEC management • Establish specific guidelines relating to water quality protection and prescribed burning e.g. location of firebreaks, sumps and drains, and appropriate herbicide use. • Ensure guidelines are included in burning prescription. • WC staff should continue to attend all fires in proposed water reserve. • Ensure the PSC 88 and Statewide Policy No 2: <i>Pesticide use in public drinking water source areas</i>, are used, if pesticide use is required. |
| | Carbon and nutrient contamination from airborne and eroded ash when fuel reduction burning | Low | | | |
| | Fuel spills from vehicles and machinery | Medium | | | |
| | Pathogens from firefighters | Medium | | | |
| | Pesticide contamination from firebreak maintenance. | Medium | | | |

| Land use/activity | Potential water quality risks | | Consideration for management | Current preventative measures | Recommended protection strategies |
|--|-------------------------------|---------------------|---|---|---|
| | Hazard | Management priority | | | |
| Conservation reserves | | | | | |
| Bushwalking and caving | Pathogens from human activity | Low | <ul style="list-style-type: none"> • Little activity is reported | <ul style="list-style-type: none"> • Location of caves not common knowledge nor easily accessed. • Chlorination. • Residence time. | <p><i>Acceptable activity with controls, but not in WHPZ.</i></p> <ul style="list-style-type: none"> • Best practice management as recommended in <i>WQPN Tracks and trails near sensitive water resources.</i> |
| Camping and picnicking | Pathogens from human activity | Low | <ul style="list-style-type: none"> • Little activity is reported | <ul style="list-style-type: none"> • No designated camping or picnic sites. • Chlorination. • Residence time. | <ul style="list-style-type: none"> • These activities are not supported in the water reserve except where controlled and managed at DEC authorised localities. |
| <ul style="list-style-type: none"> • Apiarists • Wildflower picking • Seed collection | Pathogens from human activity | Low | <ul style="list-style-type: none"> • Little activity is reported | <ul style="list-style-type: none"> • Activity controlled by DEC with permits. • Chlorination. • Residence time. | <ul style="list-style-type: none"> • Continued DEC management through permitting. • Acceptable activity with controls, but not in WHPZ. • Continuation of water quality monitoring and surveillance program. |

| Land use/activity | Potential water quality risks | | Consideration for management | Current preventative measures | Recommended protection strategies |
|--|---|---------------------|--|--|---|
| | Hazard | Management priority | | | |
| Off road vehicle use on and off tracks | Hydrocarbons and chemicals from spills (refuelling or accidents). Pathogens from litter and human activity | Low Low | <ul style="list-style-type: none"> • Tracks in poor condition. • Little activity is reported. | <ul style="list-style-type: none"> • Monitoring and surveillance by DEC and WC. • Residence time. | <p><i>Unauthorised vehicle use is not an acceptable activity within a water reserve or WHPZ.</i></p> <ul style="list-style-type: none"> • Further signage to access roads and catchment boundaries as approved. • Ongoing monitoring, surveillance and management by DEC and WC |
| Illegal hunting | Pathogens from human and animal activity (litter, carcasses etc. | Low | <ul style="list-style-type: none"> • Access limited. • Little activity is reported. | <ul style="list-style-type: none"> • Monitoring and surveillance by DEC and WC. • Residence time. • Chlorination. | <p><i>Hunting is not an acceptable activity in the water reserve.</i></p> <ul style="list-style-type: none"> • Further signage to access roads and reserve boundary as approved. |
| Illegal activities <ul style="list-style-type: none"> • drug growing • wildflower picking • seed collection | Pathogens from human and animal activity Fertiliser application | Low Medium | <ul style="list-style-type: none"> • Little activity is reported. • Illegal activity could increase with ease of access. | <ul style="list-style-type: none"> • Residence time. • Chlorination. | <p><i>Illegal activities are not acceptable within the water reserve.</i></p> <ul style="list-style-type: none"> • DEC permits required for wildflower picking and seed collection. |

| Land use/activity | Potential water quality risks | | Consideration for management | Current preventative measures | Recommended protection strategies |
|-------------------|--|---------------------|---|--|---|
| | Hazard | Management priority | | | |
| Fire management | Increased turbidity in recharging surface waters | Low | <ul style="list-style-type: none"> • Fire management through fire pre-suppression and suppression. • Fuel reduction burning is an established essential land management practice, but should be managed to reduce risk to wellfield infrastructure. | <ul style="list-style-type: none"> • Fire management controls by experienced DEC officers. • State Wildfire Emergency Management Plan. • Burn prescriptions for DEC managed land give consideration to water quality protection in the pre-burn prescription and during implementation. | <p><i>Acceptable activity with best management practices</i></p> <ul style="list-style-type: none"> • Continued DEC management • Establish specific guidelines relating to water quality protection and prescribed burning e.g. location of firebreaks, sumps and drains and appropriate herbicide use. • Ensure guidelines are included in burning prescription. • WC staff should continue to attend all fires in proposed water reserve. • Ensure PSC 88 and Statewide Policy No 2: <i>Pesticide use in public drinking water source areas</i>, are used, if pesticide use is required. |
| | Carbon and nutrient contamination from airborne and eroded ash when fuel reduction burning | Low | | | |
| | Fuel spills from vehicles and machinery | Medium | | | |
| | Pathogens from firefighters | Medium | | | |
| | Pesticide contamination from firebreak maintenance | Medium | | | |

| Land use/activity | Potential water quality risks | | Consideration for management | Current preventative measures | Recommended protection strategies |
|---|---------------------------------------|---------------------|---|--|---|
| | Hazard | Management priority | | | |
| Rural Land | | | | | |
| Broad acre cropping: <ul style="list-style-type: none"> • wheat • barley • lupins • canola | Nutrients from fertiliser application | Medium | <ul style="list-style-type: none"> • Cereal cropping dominant with some tagasaste. Farms apply nitrogen and phosphorous to the soil with soil and plant testing often used to optimise application rates. No-tillage farming is becoming more common. | <ul style="list-style-type: none"> • Water quality monitoring. • Signage - at wellfield and Jurien Groundwater Area. • Chlorination. • Zoning restrictions. | <ul style="list-style-type: none"> • Best practice management as in <i>WQPN Agriculture – dryland crops near sensitive water resources</i> and Department of Agriculture and Food Farm note series. |
| | Pesticides and herbicides | Medium | <ul style="list-style-type: none"> • Herbicides used in the area include glyphosate, simazine, atrazine and others with application usually occurring at seeding and 4 to 8 weeks later if required. Simazine and atrazine known to cause contamination of groundwater. • Pesticides used include chlorpyrifos, cypermethrin, alphamethrin and others with application as required. | <ul style="list-style-type: none"> • Water quality monitoring. • Sealed bores and fenced compound. • Chlorination. • Signage - at wellfield and Jurien Groundwater Area. | <ul style="list-style-type: none"> • Best practice management for application of pesticides and herbicides. Statewide Policy No.2 <i>Pesticide use in public drinking water source areas</i> and PSC 88. |

| Land use/activity | Potential water quality risks | | Consideration for management | Current preventative measures | Recommended protection strategies |
|--|--|--------------------------------|--|---|---|
| | Hazard | Management priority | | | |
| Stock grazing: <ul style="list-style-type: none"> • sheep • cattle | Nutrients from animal manure Pathogens from animal manure | Medium/high Medium/high | <ul style="list-style-type: none"> • Sheep and cattle grazing are generally secondary land uses to cropping in the area and stocking rates are usually low. | <ul style="list-style-type: none"> • Water quality monitoring. • Sealed bores and fenced compound. • Chlorination. • Signage. | <ul style="list-style-type: none"> • Best practice management as recommended. |
| Residences | Pathogens and nutrients from septics, gardens and animals | Medium/high | <ul style="list-style-type: none"> • Limited number of residences on properties | <ul style="list-style-type: none"> • Residence time. • Chlorination. • Zoning restrictions on land uses. | <ul style="list-style-type: none"> • Land planning assessment and approvals in accordance with the Shire's planning strategy. • Consideration of Department of Water's <i>WQPN Land use compatibility in PDWSA</i>. • Best management practices. |
| Workshops/fuel storages | Hydrocarbons and chemicals from fuel and chemical spills | Medium | <ul style="list-style-type: none"> • Bulk fuel storage on properties is likely. • Storage volumes and bunding not assessed. | <ul style="list-style-type: none"> • DoMP approval for bulk fuel storages in PDWSAs. • Residence time. | <ul style="list-style-type: none"> • Best management practices – see WQPNs on fuel/chemical storage. • DoMP approvals |

| Land use/activity | Potential water quality risks | | Consideration for management | Current preventative measures | Recommended protection strategies |
|--|---|---------------------------|--|--|---|
| | Hazard | Management priority | | | |
| Roads (unsealed) | Hydrocarbons and chemicals from spills. Pathogens from litter Nutrients from accidents or spills involving fertiliser | Low Low Low | <ul style="list-style-type: none"> • Low traffic levels, mainly local. | <ul style="list-style-type: none"> • Residence time (pathogens). | <ul style="list-style-type: none"> • Best management practices (see this Department's WQPNs). |
| Existing Rural residential (Alta Mare Estate) | | | | | |
| Domestic animals | Pathogens and nutrients from animal excreta | Medium | <ul style="list-style-type: none"> • Low stock levels only. • Agricultural pursuits not permitted. | <ul style="list-style-type: none"> • Residence time. • Zoning restrictions. • Chlorination. | <ul style="list-style-type: none"> • Ownership of domestic animals within Local Government requirements is acceptable. • Development of catteries and/or kennels not compatible in P1 areas but acceptable with conditions in P2 areas. |

| Land use/activity | Potential water quality risks | | Consideration for management | Current preventative measures | Recommended protection strategies |
|------------------------|--|---------------------|---|---|--|
| | Hazard | Management priority | | | |
| Workshops and vehicles | Hydrocarbons and chemicals from fuel and chemical spills | Medium | <ul style="list-style-type: none"> • Workshop related businesses or vehicle repairs not permitted. | <ul style="list-style-type: none"> • Bulk fuel storage over 2500L in PDWSAs requires DoMP approval. • Zoning restrictions to limit density. | <ul style="list-style-type: none"> • These activities are not acceptable within the proposed water reserve. |

| Land use/activity | Potential water quality risks | | Consideration for management | Current preventative measures | Recommended protection strategies |
|-------------------|--|--------------------------------------|--|--|---|
| | Hazard | Management priority | | | |
| Residences | <p>Pathogens and nutrients from septic systems</p> <p>Fertiliser and pesticide use on lawns and gardens</p> <p>Chemicals of concern from waste water recycling</p> | <p>High</p> <p>Low</p> <p>Medium</p> | <ul style="list-style-type: none"> • Unsewered lots of one to two hectares create a subdivision density that may compromise scheme water quality. • Land planning zoning provisions limit clearing of natural vegetation. • Commercial operations related to horticulture and dryland farming (including pastoral grazing) not permitted. | <ul style="list-style-type: none"> • Rural residential zoning special provisions enacted by the Shire. • Properties 2 ha minimum. • 1 residence per property. • ATUs in residences | <ul style="list-style-type: none"> • Ensure Special Provisions for the Rural Residential Zone control development are enacted. • Encourage landowners to adopt best management practices (allowed activities). • Oppose intensification of land use through planning approval process. • Support changes within existing approvals that reduce groundwater contamination risks. • Encourage connection to deep sewerage through planning approval process. • Promote water quality protection, particularly by use of priority classification areas and WHPZ. |

| Land use/activity | Potential water quality risks | | Consideration for management | Current preventative measures | Recommended protection strategies |
|---|--|---------------------|---|---|---|
| | Hazard | Management priority | | | |
| Potential future rural subdivisions | | | | | |
| Potential for future rural subdivisions on private land <ul style="list-style-type: none"> • residences • animals • workshops • vehicles • bores | Pathogens, nutrient, hydrocarbons and chemicals as per existing subdivisions | High | <ul style="list-style-type: none"> • Private land for subdivision could be immediately upstream of wellfield. • High risk of groundwater contamination. • Potential for private bores to affect availability of water to wellfield, and its quality. | <ul style="list-style-type: none"> • Current zoning is rural. | <ul style="list-style-type: none"> • Consider subdivision proposals consistent with priority area (P1 or P2) in this protection plan. • See recommendations section of this protection plan |
| Potential intensive agriculture and horticulture | | | | | |
| Intensive agriculture | Nutrients Pesticides Hydrocarbons | Medium | <ul style="list-style-type: none"> • No intensive agriculture is present or envisaged at this point in time. • Potential for nutrient contamination from such developments (see Woodridge example). | <ul style="list-style-type: none"> • Water quality monitoring. • Land use planning approvals process. | <ul style="list-style-type: none"> • LGA to refer development proposals inconsistent with the Department of Water's WQPN <i>Land use compatibility in PDWSA</i> to the Department of Water for advice and recommendations. |

| Land use/activity | Potential water quality risks | | Consideration for management | Current preventative measures | Recommended protection strategies |
|--------------------------|---|-------------------------|--|---|---|
| | Hazard | Management priority | | | |
| Horticulture (potential) | Fertiliser and pesticide use on crops | High | <ul style="list-style-type: none"> No horticultural practices are present or envisaged at this point in time. Potential for nutrient contamination from such developments (see Woodridge example). The presence of the Bassendean Precinct Special Control Area recognises the high leaching capacity of the soil and subsoil and the potential for contamination of shallow groundwater. | <ul style="list-style-type: none"> None at present. | <ul style="list-style-type: none"> Oppose intensification of land use through planning approval process. Support changes in land use within existing approvals that reduce groundwater contamination risks. |
| | Contamination from hydrocarbons and chemicals | Medium | | | |
| | Nutrients and bacteria from septic tanks | Low/medium | | | |
| Other activities | | | | | |
| Mineral exploration | Hydrocarbons Nutrients Pathogens | Low Medium Medium | <ul style="list-style-type: none"> Exploration bores can potentially provide a pathway for contaminants to travel down into the semi-confined aquifer. | <ul style="list-style-type: none"> DoMP place specific conditions on mining tenements in a Water Reserve. Water quality monitoring. Sealed bores and fenced compounds. | <ul style="list-style-type: none"> Exploration drilling should be located outside the WHPZ. All exploration bores drilled within the water reserve should be backfilled and sealed in an approved manner. |

| Land use/activity | Potential water quality risks | | Consideration for management | Current preventative measures | Recommended protection strategies |
|--|---|---------------------------|---|---|---|
| | Hazard | Management priority | | | |
| Public purpose – school (potential) | <p>Nutrients and bacteria from septic tanks, fertiliser and pesticide use on lawns.</p> <p>Contamination from hydrocarbons and other chemicals</p> | <p>High</p> <p>Medium</p> | <ul style="list-style-type: none"> The site was previously used as for rubbish and sewage disposal however it is no longer being used. Site is located within a WHPZ of abstraction bores. | <ul style="list-style-type: none"> None at present | <ul style="list-style-type: none"> The purpose of Reserve 25471 should be changed to “Water Supply Protection Purposes” and consideration given to vesting with the Department of Water. |
| Landfill site (Reserve 25471) and other illegal rubbish dumping. | <p>Pathogens from domestic rubbish</p> <p>Nutrients, chemical, heavy metal, hydrocarbon contamination from domestic, building or industrial waste</p> | <p>High</p> <p>High</p> | <ul style="list-style-type: none"> Identified landfill site on Reserve 25471 unlikely to be used. Any future landfill site should be located outside of proposed water reserve. Illegal rubbish dumping is often associated with unauthorised recreation or access to the reserve. | <ul style="list-style-type: none"> None | <p><i>Landfills and illegal rubbish dumping not an acceptable land activity in proposed water reserve.</i></p> <ul style="list-style-type: none"> Any proposed landfill site to be referred to the Department of Water for comment. Landfill management to be managed under <i>Environmental Protection Act 1986</i> for licensing and inspections Maintain surveillance and by-law enforcement, with signage. |

| Land use/activity | Potential water quality risks | | Consideration for management | Current preventative measures | Recommended protection strategies |
|--|--|---------------------|---|---|--|
| | Hazard | Management priority | | | |
| Gravel pits and quarry sites Lot 12320 of Reserve 18865, and Reserve 35190 of Victoria Location 11231 | Turbidity from extraction practices | Low | <ul style="list-style-type: none"> Gravel pits often focal points for illegal recreational activity and rubbish dumping. Gravel pits and quarries used for road maintenance require effective site management to reduce risks to water quality. | <ul style="list-style-type: none"> Relevant policy statements and guidelines specified in Department of Water's WQPN <i>Extractive industries within PDWSAs</i>. Any new pits established by DEC are usually rehabilitated after use. | <p><i>Acceptable activity with best management practices.</i></p> <ul style="list-style-type: none"> All sites should be rehabilitated after decommissioning. Ensure no gravel pits or quarries are within WHPZ. Inspect water quality measures on site. Ensure contract specifications recognise water quality protection objectives. |
| | Fuel and chemical spills from vehicles and machinery | Medium | | | |
| | Pathogens from people involved in illegal recreation | Medium | | | |
| | Illegal rubbish dumping | Medium | | | |

4 Catchment protection strategy

4.1 Protection objectives

The objective of this plan is to protect the public drinking water source for the town of Jurien and its extended development, by ensuring that the quality of the water is not compromised and public health placed at risk.

The measures and management practices recommended in this plan are aimed at avoiding, minimising, or managing the risk of groundwater contamination, depending on the vulnerability of the source to contamination, the strategic nature of the resource and the existing land use in the area.

The plan also recommends practises to avoid the risk of over-development in the proposed reserve, by the placing of some licensing requirements, to ensure sustainability of supply to the wellfield (see Section 2.4)

The boundary recommended for the Jurien Water Reserve has been determined on the basis of sound science, including drilling investigations and assessment, and groundwater modelling. Priority classifications have been assigned to ensure consistency with the Department of Water's current framework for public drinking water source protection and decisions made by the Minister for Water.

4.2 Proclaimed area

The Department of Water recognises that strategic water planning and protection of public drinking water supply resources is critical for the future development of Jurien. Detailed investigations were undertaken to determine the best approach for securing significant additional quantities of water. These investigations considered current and future environmental, social and economic aspects.

Hydrogeological data and groundwater modelling of the area were used to define the recharge zone and catchment area of the future wellfield. This information then determined the location of the proposed water reserve boundary, primarily on the basis of the nature of aquifer systems and groundwater flows. Land uses and land tenure were not considered at this time. The proposed water reserve represents the hydrogeological system associated with larger wellfield and the area of land required to protect the public water supply. The proposed water reserve boundary is a significant extension to the water reserve as identified in the original 1999 Drinking Water Source Protection Plan.

The Department of Water recognises the presence of private land within the proposed water reserve and the potential implications for affected landowners within this area. Irrespective of the priority classifications given for the water reserve, existing land uses are recognised and able to continue in accordance with best management practices. Ideally (for maximum water quality protection), all rural land

uses should be compatible with the assigned priority area as per the Department's Water quality protection note *Land use compatibility in public drinking water source areas*. However, if a proposed future rural land use is not recommended in the above protection note but is consistent with the Shires approved Local Planning Scheme, that proposed rural land will be determined by the Shires planning processes.

The Department of Water also recognises that parts of the proposed water reserve fall within conservation reserves managed by the Department of Environment and Conservation on behalf of the Conservation Commission of Western Australia, through the *Conservation and Land Management Act 1984*.

The Department of Water considers that the water reserve area and the priority area classification assigned for the reserve, as outlined in this Plan, is the best approach for the protection the Jurien town water supply into the future.

The proposed boundary of the Jurien Water Reserve and its priority classifications is shown on Figure 6.

The reserve is proposed to be proclaimed under the *Country Area Water Supply Act 1947* and will include a 500 metre wellhead protection zone around each of the existing and future production bores.

4.3 Priority areas

The protection of PDWSAs relies on 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.
- Priority 3 (P3) areas have the fundamental water-quality objective of risk mitigation.

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 detail, 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 proposed Jurien Water Reserve (P1 and P2 only) have been determined in accordance with current Department of Water policy. 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 Water quality protection note: *Protecting public drinking water source areas*.

It is proposed to classify all Crown land and Location 10599 (Lot 501) within the Water Reserve as Priority 1.

The remaining parts of the Water reserve are proposed to be classified as Priority 2. Location 10602 should remain as Priority 2 as previously classified in recognition of the current zoning and the rural residential developments on the land, although the southern boundary of the reserve extends further to the south than in the 1999 plan.

Upon request the department sought advice from Landgate in relation to the impact of a P2 classification on the value of private land. Landgate assessed privately owned rural properties with a P2 classification in areas similar to the proposed Jurien Water Reserve. The advice provided indicates that there has been no measurable impact on the market value of those properties. It is also clear from that assessment that placing a P2 area over rural land in a water reserve does not prevent the land from being farmed.

The proposed reserve and the priority areas are shown in Figure 6.

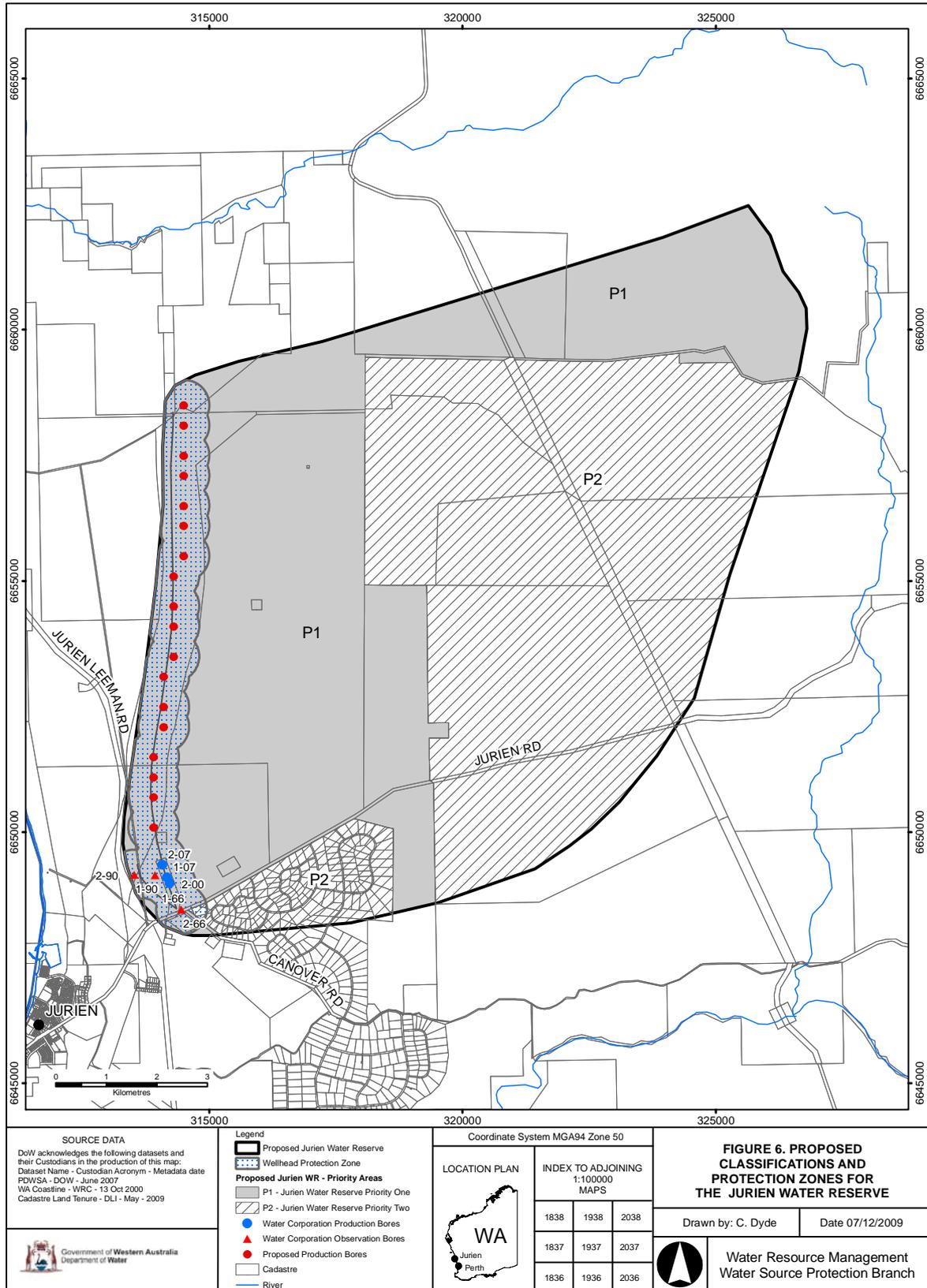
4.4 Protection zones

In addition to priority areas, specific protection zones are defined to protect drinking-water sources from contamination in the immediate vicinity of water extraction facilities. The *Country Areas Water Supply Act 1947* by-laws 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-metre radius around each production bore in a P1 area and a 300-metre radius around each production bore in P2 and P3 areas. WHPZ do not extend outside the boundary of the water reserve.

All the production bores for the proposed Jurien Water Reserve, both existing and future, are located in a Priority 1 area. Hence each bore will have a WHPZ with a 500 metre radius.

The WHPZ are shown on Figure 6.



J:/gisprojects/Project/B_Series/B2010/0056_JurienWR/mxd/JurienFig6_A4_Amendment_7Dec09.mxd

Figure 6 Proposed classification and protection zones for the Jurien Water Reserve

4.5 Land-use planning

It is recognised under the *State planning strategy* (Western Australian Planning Commission 1997) that the establishment of appropriate protection mechanisms in statutory land-use-planning processes is necessary to secure the long-term protection of drinking-water sources. As outlined in Statement of planning policy: *Public drinking water source policy* (Western Australian Planning Commission 2003) it is appropriate that the Jurien Water Reserve, priority areas and protection zones be recognised in the Shire of Dandaragan's local planning scheme. Any development proposals within the Jurien 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 please refer to the *State Water Plan 2007* (Government of Western Australia 2007) and the Department of Water's Water quality protection note: *Protecting public drinking water source areas*.

The Department of Water also recognises that the Department of Environment and Conservation (DEC) have statutory planning processes that apply to *Conservation and Land Management Act 1984* managed lands. On these lands the WAPC processes do not necessarily apply. Any actions therefore that are being considered for DEC-managed land under the *Conservation and Land Management Act 1984* that may affect water quality should be referred to the Department of Water for comment.

The department's protection strategy for public drinking water source areas (PDWSA) provides for lawfully established and operated developments to continue despite their location or facilities posing a level of risk to water quality which 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 locations, such as P1 areas, the department has developed a policy that allows it to approach land owners with a view to purchase land or to discuss 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 adoption of best management practices for land uses will continue to be encouraged to help protect water sources. On freehold land, the Department of Water aims to work with landowners by providing management advice to achieve sound management practices for the protection of water quality.

There are guidelines for many land uses 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 “Agriculture – dryland crops near sensitive water resources”, “Stockyards”, “Nutrient and Irrigation Management Plan”, and “Pesticide use in Public Drinking Water Source Areas”, which are listed in the *Bibliography* section of this document. The guidelines help managers reduce the water quality impacts of their operations and are the recommended practice to ensure the protection of water quality.

Education and creating awareness (e.g. signage and information) are also key mechanisms for protecting the quality of water, especially for those people visiting the area who are unfamiliar with the Jurien Water Reserve. A brochure has been developed, describing the Jurien Water Reserve, its location and the main threats to water quality. This brochure is available to the community and informs 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*. Declaration of these areas 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, as an important mechanism to protect water quality.

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

Where signage is required and surveillance and enforcement activities need to be undertaken on conservation reserves vested with the Conservation Commission, the support and co-operation of the Department of Environment and Conservation will be sought, and appropriate permits obtained as necessary to protect the biodiversity values of the area.

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 Dandaragan’s local emergency management committee (LEMC), through the Mid-West emergency management district, should be familiar with the location and purpose of the Jurien Water Reserve.

A locality plan should be provided to the fire and rescue services headquarters for the hazardous materials (HAZMAT) Emergency advisory team. The Department of Environment and Conservation is the lead agency for wildfire control management for the majority of the water reserve that is outside of the gazetted fire emergency

response zone. Water Corporation should have an advisory role to the HAZMAT team for incidents in the Jurien 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 Jurien 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 Jurien Water Reserve and recommends protection strategies to deal with these risks.

Following publication of this report, an implementation strategy will be drawn up based on the recommendations in Table 1. It will provide an indicative time frame for the recommended protection strategies and identify stakeholders that could be involved in implementation actions.

5 Recommendations

The following recommendations apply to the entire Jurien Water Reserve. The bracketed stakeholders are those expected to have an interest in implementation of the relevant recommendation.

- 1 The boundary of the Jurien Water Reserve should be proclaimed under the *Country Areas Water Supply Act 1947*. (Department of Water)
- 2 Prepare an implementation plan including the recommended protection strategies as detailed in Table 1 of this plan. (Department of Water, applicable stakeholders)
- 3 The Shire of Dandaragan's local planning scheme should incorporate this plan and reflect the identified Jurien Water Reserve boundary, priority 1 and 2 areas and protection zones in accordance with Statement of planning policy: Public drinking water source policy. (Shire of Dandaragan)
- 4 All development proposals within the Jurien 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. Additionally, the following conditions are important for inclusion in the Shires new Local Planning Scheme in relation to any proposed subdivision of rural land in P2 areas:
 - a minimum lot size of 4 hectares in P2 areas for new subdivisions in areas over limestone resources, and a 2 hectare minimum with an average of 4 hectares in other P2 areas;
 - alternative treatment units for each lot are to be required within P2 areas for new subdivision approvals;
 - new bores being assessed at the subdivision application stage against data that is available at that time. Additional hydrogeological data may be required by the Department of Water at this stage from the proponent to allow assessment of any proposed new bores;
 - vegetation clearing is to be prohibited for new subdivision approvals, only allowing for defined building blocks (including rain water tank storage), access ways and fencing; and
 - the carrying of livestock for commercial gain is to be prohibited for subdivision approvals. An assessment of the carrying capacity of the land is required to demonstrate domestic livestock (e.g. pet horses) can be supported. Based on available data at the time of an application, it may also be appropriate to further limit the total number of domestic livestock on lots to protect water quality and quantity.

(Department for Planning, Shire of Dandaragan, proponents of proposals, Department of Water)

- 5 The statutory management planning processes of the Department of Environment and Conservation (DEC) under the *Conservation and Land Management Act 1984* should be noted and both the Department of Water and DEC should work

cooperatively to ensure that management planning and source protection are mutually inclusive. (Department of Water, Department of Environment and Conservation)

- 6 Any developments in the Jurien water reserve proposed for land managed by the Department of Environment and Conservation under the *Conservation and Land Management Act 1984* should be referred to the Department of Water for comment with respect to implications for water quality protection (Department of Environment and Conservation)
- 7 Incidents covered by WESTPLAN - HAZMAT in the Jurien Water Reserve should be addressed by ensuring that:
 - the Shire of Dandaragan's LEMC should be aware of the location and purpose of the Jurien Water Reserve
 - the locality plan for the Jurien 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 Jurien Water Reserve
 - personnel dealing with WESTPLAN - HAZMAT incidents in the area have ready access to a locality map of the Jurien Water Reserve and information to help them recognise the potential impacts of spills on drinking water quality.(Department of Water, Water Corporation)
- 8 The existing monitoring program should be maintained to identify any incompatible land uses or potential threats within the Jurien Water Reserve. This program should be carried out in conjunction with surveillance undertaken by the Department of Environment and Conservation (DEC) on DEC-managed land and working in cooperation with the Department of Water and the Water Corporation. (Department of Water, Water Corporation, Department of Environment and Conservation).
- 9 Signs should be erected along the boundary of the Jurien Water Reserve to define the location and promote awareness of the need to protect drinking water quality. Signs should include an emergency contact telephone number. Signage in reserves managed by the Department of Environment and Conservation should occur in consultation with that agency. (Water Corporation, Department of Environment and Conservation)
- 10 A review of this plan should be undertaken after five years. (Department of Water)
- 11 The owners of any bores identified as penetrating the Lesueur Sandstone should be advised of the requirements for licensing within this aquifer (Department of Water).
- 12 Any exploration bores drilled within the Jurien Water Reserve should be backfilled in an approved manner (Proponent, Department of Water)
- 13 The purpose of Reserve 25471 should be changed to 'Water Supply Protection Purposes' and consideration given to vesting with the Department of Water.

- 14 The portion of Reserve 18865 within the Jurien Water Reserve should be reserved for 'Water Supply Protection Purposes' and consideration given to vesting with the 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 the Jurien 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 are representative of the quality of raw water from the Jurien 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 April 2003 to April 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 the Jurien Water Supply Scheme refer to the most recent Water Corporation drinking water quality annual report at <www.watercorporation.com.au> > Water > Water quality > Latest report > Drinking water quality annual report.

Aesthetic

The aesthetic quality analyses for raw water from Jurien Borefield are summarised in the following table. Hardness and salinity at Jurien are slightly above the ADWG aesthetic guidelines. Hardness is treated by Calgon™ to reduce levels.

Aesthetic detections for Jurien Borefield

| Parameter | Units | ADWG aesthetic guideline value* | Jurien Borefield | |
|--------------------------------------|---------|---------------------------------|------------------|--------|
| | | | Range | Median |
| Colour (true) | TCU | 15 | <1 - 2 | <1 |
| Conductivity | mS/m | - | 110 - 140 | 127.5 |
| Hardness as CaCO ₃ | mg/L | 200 | 296 - 303 | 299.5 |
| Iron unfiltered | mg/L | 0.3 | <0.003–0.147 | <0.003 |
| Manganese unfiltered | mg/L | 0.1 | <0.002–0.006 | <0.002 |
| Sodium | mg/L | 180 | 115 - 135 | 125 |
| Sulfate | mg/L | 250 | 22 - 26 | 24 |
| Total filterable solids by summation | mg/L | 500 | 755 - 811 | 783 |
| Turbidity | NTU | 5 | <0.1–1.2 | <0.1 |
| pH measured in laboratory | no unit | 6.5–8.5 | 7.18 – 7.5 | 7.275 |

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

Health related

Health-related chemicals

Raw water from Jurien Borefield is analysed for chemicals that are harmful to human health, including categories of chemicals such as inorganics, heavy metals, industrial hydrocarbons and pesticides. All health-related parameters were below ADWG guideline values. Health-related parameters that impact on water quality are summarised in the following table.

Health-related detections for Jurien Borefield

| Parameter | Units | ADWG health guideline value* | Jurien Borefield | |
|--|-------|------------------------------|------------------|--------|
| | | | Range | Median |
| Barium [^] | mg/L | 0.7 | 0.025 | 0.025 |
| Boron [^] | mg/L | 4 | 0.02–0.06 | 0.04 |
| Fluoride | mg/L | 1.5 | 0.4 – 0.5 | 0.45 |
| Nitrate as nitrogen [^] | mg/L | 11.29 | 2.4 – 2.6 | 2.5 |
| Nitrite plus nitrate as N [^] | mg/L | 11.29 | 2.7 – 2.9 | 2.8 |

* 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 3 or less sampling occasions.

Microbiological contaminants

Microbiological testing of raw-water samples from Jurien 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 being an indication of raw water that has not been recently contaminated with faecal material.

During the reviewed period, no positive *Escherichia coli* counts were recorded.

Appendix B Photographs



Figure B1 Jurien Wellfield - looking north along proposed extension



Figure B2 View from Gingin scarp to west overlooking private land east of Cockleshell Gully Road



Figure B3 View from Cockleshell Gully Road to west overlooking private land



Figure B4 Existing rural subdivision - Alta Mare

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 |
| DEC | Department of Environment and Conservation |
| EC | electrical conductivity |
| GL | gigalitre |
| ha | hectare |
| HAZMAT | hazardous materials |
| kL | kilolitre |
| km | kilometre |
| km² | square kilometre |
| LEMC | Local emergency management committee |
| m | metres |
| mg/L | milligram per litre |
| mL | millilitre |
| ML | megalitre |
| mm | millimetre |
| MPN | most probable number |
| mSv | millisievert |
| mS/m | millisiemens per metre |
| NHMRC | National Health and Medical Research Council |

| | |
|------------------------------|---|
| NRMMC | Natural Resource Management Ministerial Council |
| NTU | nephelometric turbidity units |
| PSC 88 | public sector circular number 88 |
| PDWSA | public drinking water source area |
| RPZ | reservoir protection zone |
| TCU | true colour units |
| 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. |
| Adsorb | Accumulate on the surface. |
| ADWG | The Australian Drinking Water Guidelines, outlining guideline criteria for the quality of drinking water in Australia. |
| Aesthetic guideline | An Australian Drinking Water Guidelines value which is the concentration of measure of a water quality characteristic that is associated with acceptability of water to the consumer for example, appearance, taste and odour (NHMRC & NRMCC, 2004a). |
| AHD | Australian Height Datum is the height of land in metres above mean sea level. For example, this is +0.026 m at Fremantle. |
| Allocation | The quantity of water permitted to be abstracted by a licence, usually specified in kilolitres per annum (kL/a). |
| Anisotropic | Having different properties in different directions. |
| ANZECC | Australian and New Zealand Environment Conservation Council. |
| Aquifer | A geological formation or group of formations able to receive, store and transmit significant quantities of water. |
| ARMCANZ | Agriculture and Resource Management Council of Australia and New Zealand. |
| Augment | To increase the available water within a storage dam by pumping back water from a secondary storage/reservoir dam. |
| Bore | A narrow, lined hole, also known as a well, drilled to monitor or draw groundwater. |
| Bore field | A group of bores to monitor or withdraw groundwater. |
| BPSCA | Bassendean Precinct Special Control Area |
| CA | Catchment Area. |
| Catchment | The area of land which intercepts rainfall and contributes the collected water to surface water (streams, rivers, wetlands) or groundwater. |

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| CFU | Colony forming units. A measure of pathogen contamination in water. |
| Confined aquifer | An aquifer that is confined between non-porous rock formations (such as shale and siltstone) and therefore contains water under pressure. |
| Diffuse source | Pollution originating from a widespread area, eg urban stormwater runoff; agricultural infiltration. |
| DEC | Department of Environment and Conservation |
| DoH | Department of Health |
| DoMP | Department of Mines and Petroleum (previously Department of Industry and Resources) |
| Effluent | The liquid, solid or gaseous wastes discharged by a process, treated or untreated. |
| EC | Electrical conductivity. This estimates the volume of total dissolved solids (TDS), or the total volume of dissolved ions in a solution (water) corrected to 25 ⁰ Celsius. Measurement units include milliSiemens per metre and microSiemens per centimetre. |
| GL | Gigalitre (1,000,000,000 litres) or 1 million kilolitres. |
| ha | Hectare (a measure of area). |
| HAZMAT | Hazardous Materials. |
| Health guideline | An Australian Drinking Water Guideline value which is the concentration of 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 & NRMCC 2004a). |
| Hydrogeology | The study of groundwater, especially relating to the distribution of aquifers, groundwater flow and groundwater quality. |
| Karstic | Landscape shaped by the dissolution of a layer or layers of soluble bedrock, usually carbonate rock such as limestone or dolomite. |
| kL | Kilolitre (1000 litres) or 1 cubic metre. |
| km | Kilometre (1000 metres). |
| km² | Square kilometre (a measure of area) = 1 million square metres. |

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| Laterite | A red, porous, claylike soil formed by the leaching of silica-rich components and enrichment of aluminum and iron hydroxides. |
| 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. |
| LEMC | Local Emergency Management Committee. |
| Lithified | An unconsolidated (loose) sediment converted into solid sedimentary rock by compaction of mineral grains that make up the sediment, cementation by crystallization of new minerals from percolating water solutions, and new growth of the original mineral grains. |
| m | Metres. |
| mg/L | Milligram per litre (0.001 grams per litre) as a measurement of a total dissolved solid in a solution. |
| ML | Megalitre (1,000,000 litres). |
| mm | Millimetre. |
| MPN | Most probable number (a measure of microbiological contamination). |
| mSv | Millisievert is a measure of annual radiological dose, with a natural dose equivalent to 2mSv/yr. |
| mS/m | MilliSiemens per metre is a measure of electrical conductivity of a solution or soil and water mix that provides a measurement of salinity. |
| NHMRC | National Health and Medical Research Council. |
| NRMMC | Natural Resource Management Ministerial Council. |
| NTU | Nephelometric turbidity units are a measure of turbidity in water. |
| Nutrient load | The amount of nutrient reaching the waterway over a given timeframe (usually per year) from its catchment area. |

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| Nutrients | Minerals dissolved in water, particularly inorganic compounds of nitrogen (nitrate and ammonia) and phosphorous (phosphate) which provide nutrition (food) for plant growth. Total nutrient levels include the inorganic forms of an element plus any bound in organic molecules. |
| 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 <i>Cryptosporidium</i> and <i>Giardia</i>) and viruses). |
| Perched | An unconfined aquifer, often ephemeral or seasonal, perched on top of an impermeable horizon near the land surface and separated from deeper groundwater by an unsaturated zone. |
| 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 7 indicates an acidic solution and above 7 indicates an alkaline solution. |
| Point source pollution | Pollution originating from a specific localised source, eg sewage or effluent discharge; industrial waste discharge. |
| Pollution | Water pollution occurs when waste products or other substances (for example, effluent, litter, refuse, sewage or contaminated runoff) change the physical, chemical, biological or thermal properties of the water, adversely affecting water quality, living species and beneficial uses. |
| PDWSA (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</i> and the <i>Country Areas Water Supply Act 1947</i> . |
| PSC 88 | <i>Public Service Circular 88</i> outlines permissible pesticides that can be used in a PDWSA, as determined by the Pesticides Advisory Committee chaired by Department of Health |
| Recharge | Water infiltrating to replenish an aquifer. |

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| 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. |
| Reservoir | A reservoir, dam, tank, pond or lake that forms part of any public water supply works. |
| RPZ (Reservoir Protection Zone) | A buffer measured from the high water mark of a drinking water reservoir, and inclusive of the reservoir (usually two km). This is referred to as a 'Prohibited Zone' under the <i>Metropolitan Water Supply, Sewerage and Drainage Act By-laws 1981</i> . |
| Run of the river scheme | A scheme that takes water from a flowing river. Water is taken directly from the source and there is no detention time (storage). |
| 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 via a distribution network to customers for urban, industrial or irrigation use. |
| Storage reservoir | A major reservoir of water created in a river valley by building a dam. |

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