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

Looking after all our water needs

Busselton water reserves drinking water source protection plan

Busselton and Vasse town water supply

Water resource protection series

REPORT NO. 108
June 2009

Government of Western Australia
Department of Water and Environmental Regulation

Important information

The *Busselton Water Reserve drinking water source protection plan* (2009, WRP no.108) was reviewed in 2013 and again in 2020.

Please ensure you read the following alongside this plan to obtain all of the information about this drinking water source:

- *Busselton Water Reserve drinking water source protection review* (2013, WRP no.139)
- *Busselton Water Reserve drinking water source protection review* (2020, WRP no.193)

The 2013 and 2020 reviews consider changes that have occurred in and around the Busselton Water Reserve since the completion of the 2009 plan. Additional recommendations have been prepared to ensure the ongoing protection of this public drinking water source area:

- update the location of drinking water production bore sites that form the Busselton Water Reserve
- amend the boundaries of the Busselton Water Reserve, in consultation with Busselton Water and the City of Busselton.

You can find the 2019 *Kalbarri Water Reserve drinking water source protection review* at www.dwer.wa.gov.au or by contacting the Department of Water and Environmental Regulation on +61 8 6364 7000 or drinkingwater@dwer.wa.gov.au.

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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 Busselton water reserves drinking water source protection plan at the scale shown on the maps. While the Department of Water has made all reasonable efforts to ensure the accuracy of data in this plan, no responsibility is accepted for any inaccuracies, and persons relying on them do so at their own risk.

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

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Preface

The Department of Water has prepared this drinking water source protection plan to assess risks to water quality within the Busselton water reserves 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 a reliable, 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 Busselton's drinking water source. 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 source is not generally under threat from surface land uses because the water is drawn from a confined aquifer at depth. The source is, however, susceptible to contamination if new or existing production bores (or bores related to other land uses) are not properly constructed and maintained. Therefore, it is recommended that the Busselton water reserves are identified in the Shire of Busselton local planning scheme, consistent with Western Australian Planning Commission's *Statement of planning policy No. 2.7: Public drinking water source policy* (2003). This will reflect the importance of these bores to the growth and development of Busselton and the protection of public health.

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

Stages in development of a plan		**Comment**
1	Prepare drinking water source protection assessment document. 2008	Prepared by Busselton Water Board after initial catchment survey and preliminary information gathering.
2	Conduct stakeholder consultation. February to April 2009	Advice sought from key stakeholders using the assessment document as a tool for information and discussion.
3	Prepare draft drinking water source protection plan. April 2009	Draft protection plan developed taking into account input from stakeholders and any additional advice.
4	Release draft drinking water source protection plan. May 2009	Draft protection plan released for a four-week public consultation period.
5	**Publish approved drinking water source protection plan.**	**Final protection plan published after considering submissions. Includes recommendations on how to protect water quality. Proclamation of public drinking water source area can now occur.**

Summary

The town of Busselton is situated approximately 230 kilometres from Perth, in the south west coastal region of Western Australia.

Busselton is entirely dependent on groundwater for its water supply needs. Its groundwater is sourced from the Leederville and Yarragadee aquifers which are considered to be confined aquifer systems in this area.

The fact that this source is confined, and at depth, provides a high level of protection for water quality. It also means that land use planning within Busselton is generally not impacted by water quality protection measures normally applied to help deliver a safe drinking water to consumers. The source is however susceptible to contamination if new or existing production bores (or bores related to other land uses) are not properly constructed and maintained.

Water from this source is abstracted from eight Busselton Water production bores located in the Busselton town site. The production bores are situated at a minimum depth of approximately 200 metres from the surface.

The following strategies are recommended to maximise the protection of this drinking water source and the awareness of the public about the location and nature of its drinking water supply.

- The eight existing production bores servicing Busselton, and any future drinking water bores, should be proclaimed as Water Reserves under the *Country Areas Water Supply Act 1947*.

- The proposed water reserves and their Priority 1 (P1) classifications should be recognised in the Shire of Busselton's town planning scheme as special control areas, and in other applicable planning schemes and strategies.

- Best management practices for the approval and construction of new bores in close proximity to the proposed water reserves should be implemented.

1 Drinking water source overview

1.1 Existing water supply system

The town of Busselton is situated approximately 230 km from Perth in the south-west coastal region of Western Australia (Figure 1). The population of the Shire of Busselton now exceeds 26 000 people and this growth is projected to continue. It is one of the most popular holiday destinations in regional WA.

Busselton Water is an independent water service provider responsible for the delivery of potable water for domestic, commercial, light industrial and special rural consumers in Busselton and its environs.

The raw water used by Busselton Water is sourced from two deep aquifers (Leederville and Yarragadee) by eight production bores used to supply water to Busselton and Vasse residents.

Figure 2 shows the location of the water treatment plants within which the eight production bores occur.

1.2 Water treatment

Raw water is pumped from the deep aquifer bores to storage tanks located at Busselton Water's treatment plants (Figure 2). All raw water is then aerated and filtered via rapid sand filters. The water is subsequently disinfected using ultra-violet radiation before delivery to consumers via the Busselton Water reticulation system. The bores, storage tanks and water treatment facilities are all contained within secured treatment plant sites.

At each treatment plant, the rapid sand filters require regular back-flushing to remove iron precipitate. The water is pumped and circulated in a reverse direction, through the filter media and out into containment pits where the water either evaporates or seeps into the ground. Periodically, the pits are cleaned out to remove iron particulates that are gradually deposited.

Busselton Water has advised that it does not utilise any chemicals during the treatment process. However, if water quality problems are encountered the water could be subject to additional treatment such as chlorination.

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

1.3 Catchment details

1.3.1 Physiography

Busselton occurs on the coast of Geographe Bay at the south-western edge of the Swan Coastal Plain. The plain is about 12 to 14 km wide near Busselton and is bounded to the south-east by the Whicher Scarp, an erosional scarp that separates the Sand coastal Plain from the Blackwood Plateau to the south. Elevation at the foot of the scarp is about 40 to 50 m AHD rising to over 150 m AHD on the Blackwood Plateau. The Swan Coastal Plain is underlain by weakly consolidated Cainozoic sediments while the Blackwood Plateau is underlain by Mesozoic sedimentary rock.

1.3.2 Climate

Busselton has a Mediterranean-type climate with warm to hot summers and cool winters. Rainfall comes during winter from the cold fronts which cross the South West. For much of the year, clear blue skies prevail, ideally suited to this resort town. In summer (December to February), the average maximum temperature is 30 °C with an average minimum temperature of 16°C. In winter (June to August), the average maximum temperature is 17 °C with an average minimum temperature of 8°C. The wettest months are from May to October with a mean annual rainfall of 817mm.

1.3.3 Hydrology/hydrogeology

For a detailed discussion of the hydrogeology and geological features of the area, see Department of Water (DoW 2007; DoW 2008a; 2008b; 2008c, 2008d and 2009a, 2009b); Hirschberg (1989); Water Corporation (2005). The Busselton area falls within the Busselton–Capel Groundwater Area proclaimed under the *Rights in Water and Irrigation Act 1914* (RIWI Act).

Busselton Water and Rockwater (2001; 2006; 2008a; 2008b) show that water is extracted from artesian bores which are screened within the lower Leederville and Yarragadee aquifers. The aquifers are concealed at the surface of the Swan Coastal Plain by a veneer of sand, silt and clay comprising a superficial aquifer. The Leederville aquifer which extends from the near surface to a depth of about 200 to 275m is underlain by the Yarragadee aquifer to about 800 m depth. Shale and siltstone confining beds impede groundwater flow between the aquifer systems.

There is generally good hydraulic connection between the superficial aquifer and the immediate underlying Leederville aquifer depending on the juxtaposed lithologies. Groundwater recharge is mainly a consequence of rainfall recharge to the superficial aquifer on the coastal plain and to the Leederville and Yarragadee aquifers where they outcrop on the Blackwood Plateau to the south. Regional groundwater flow in all aquifers beneath the coastal plain is broadly from the Whicher scarp towards the sea where groundwater discharge may occur near the coast or offshore. Regional groundwater flow patterns are locally influenced by groundwater–surface water interactions, mainly along some stream courses.

1.4 Future water supply requirements

The current water source is considered suitable to meet future water supply needs at Busselton.

1.5 Existing drinking water source protection

Current measures that are undertaken by Busselton Water to ensure water source protection include bore maintenance and security fencing.

The Busselton water reserves are not currently proclaimed under the *Country Areas Water Supply Act 1947* for the purpose of public drinking water source protection. However, this will need to occur.

In 2008 Busselton Water prepared the Busselton water reserves *Drinking water source protection assessment (2008)*. This document outlined risks to water quality. This drinking water source protection plan builds upon and replaces that drinking water source protection assessment.

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 this 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 RIWI Act proclaimed groundwater areas and all artesian wells throughout the state. However, bores used for typical domestic and stock use do not require a licence.

Busselton is within the Busselton–Capel Groundwater Area proclaimed under the RIWI Act. The 2009-10 allocation licence allows Busselton Water an allocation of 7.6 GL. In 2007-2008 Busselton Water extracted a combined total of 3.8 GL.

1.6.2 The South West regional water plan

The South West is one of the fastest growing areas in the state and groundwater is in high demand. Increasing demand is leading to competition for water resources from the confined aquifers. Planning is needed to provide users with access to water and security, while meeting the needs of the environment in a drying climate. The South West regional water plan (Department of Water 2008a) provides a strategic vision and action plan for the long-term sustainable management of the region's water resources and water services. The draft plan was released for public comment in June 2008 and the final plan is expected to be released in 2009. The South West regional water plan and this plan refer to other important water resource management documents (see References and further reading) prepared by the Department of Water for the South West.

1.6.3 The South West groundwater areas allocation plan

The Department of Water manages how much water is taken from rivers and groundwater systems by developing water allocation plans. The South west groundwater areas allocation plan (Department of Water 2009a) sets out where water is available, the policies for how all groundwater abstraction and use will be managed in the area, and how the ecological, social and economic needs for water have been considered. The plan also provides for water trading in fully allocated resources.

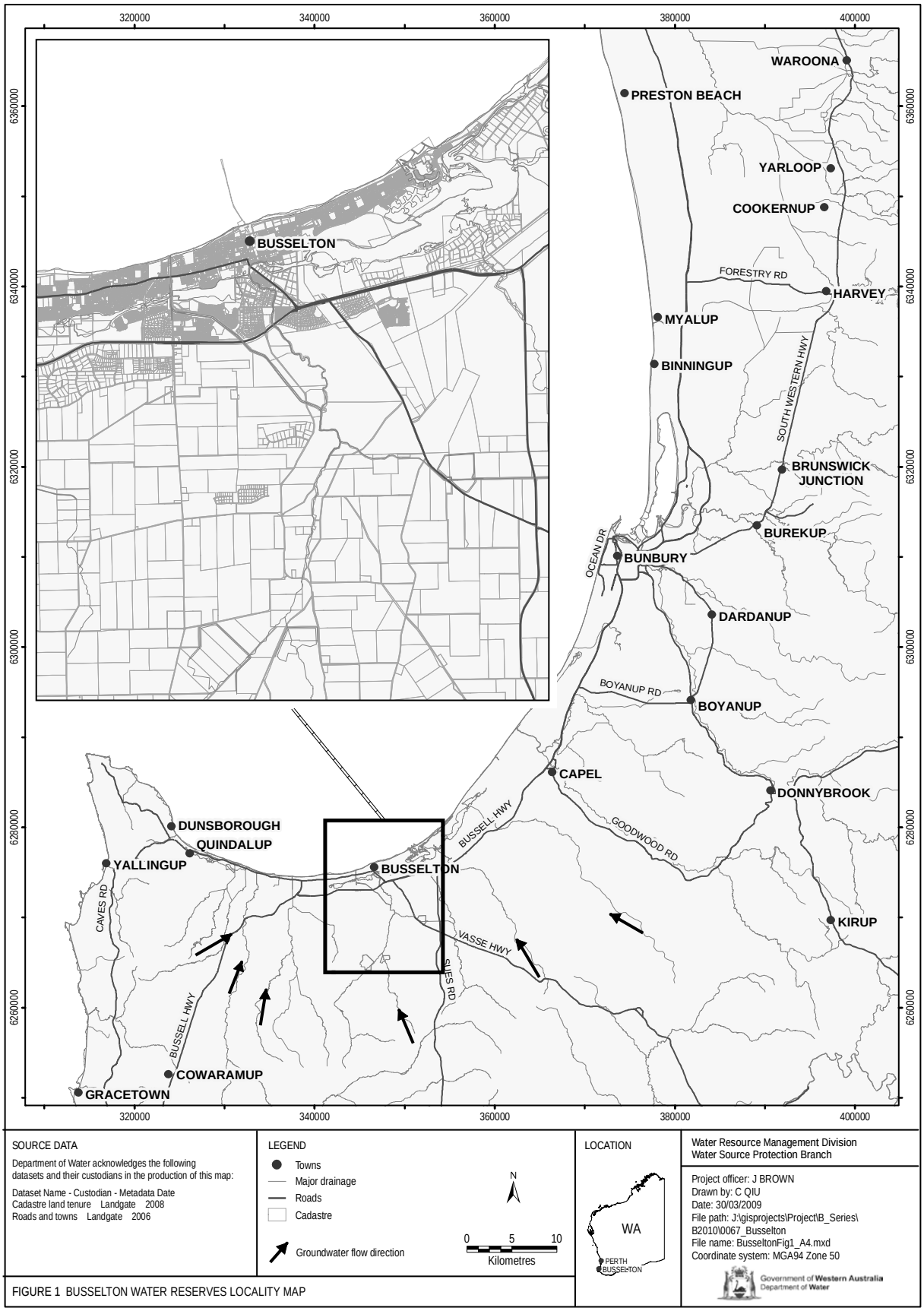
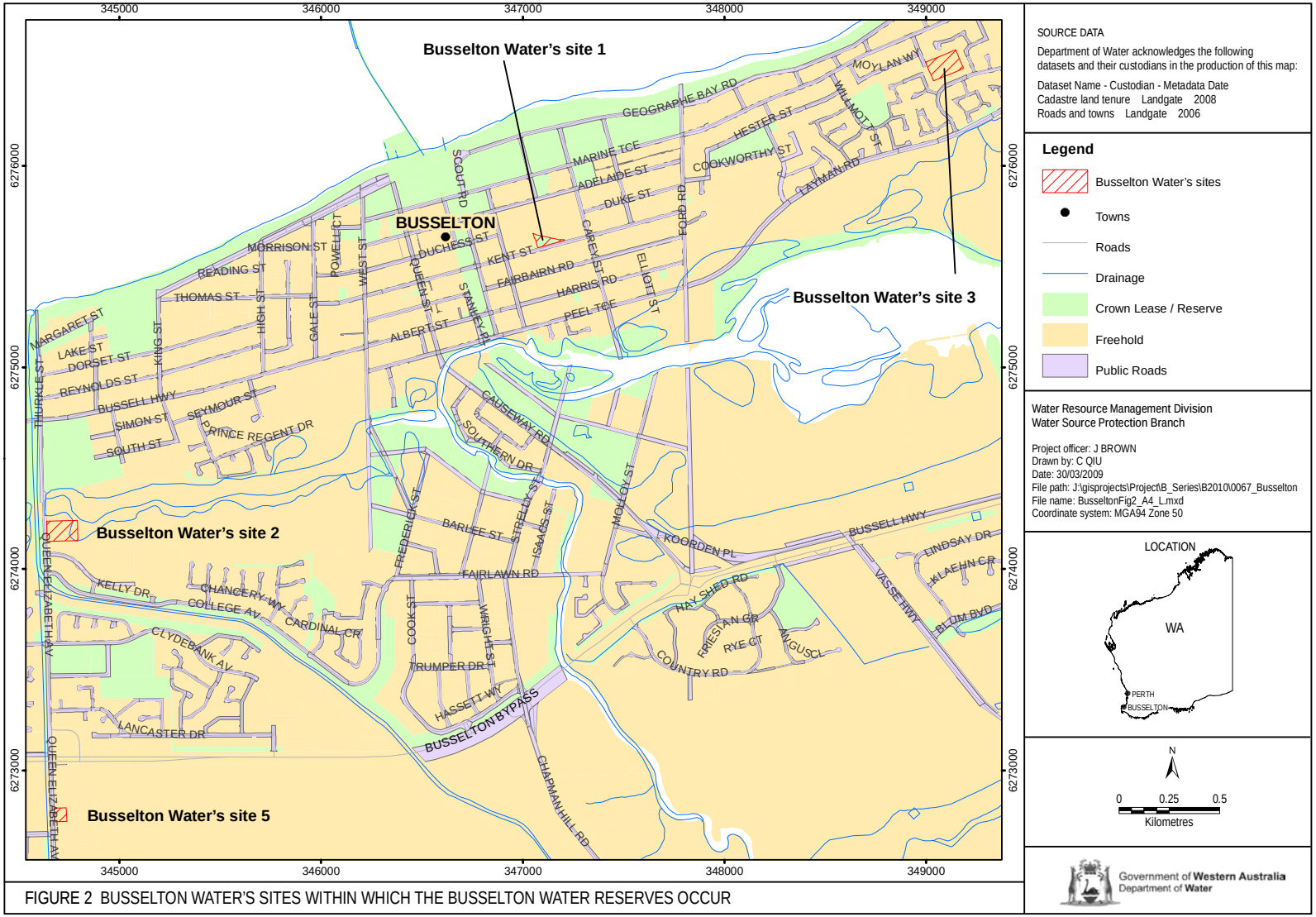


Figure 1 Proposed Busselton water reserves locality map



SOURCE DATA

Department of Water acknowledges the following datasets and their custodians in the production of this map:

Dataset Name - Custodian - Metadata Date
Cadastre land tenure Landgate 2008
Roads and towns Landgate 2006

Legend

- Busselton Water's sites
- Towns
- Roads
- Drainage
- Crown Lease / Reserve
- Freehold
- Public Roads

Water Resource Management Division
Water Source Protection Branch

Project officer: J BROWN
Drawn by: C QIU
Date: 30/03/2009
File path: J:\gisprojects\Project\B_Series\B2010\0067_Busselton
File name: BusseltonFig2_A4_L.mxd
Coordinate system: MGA94 Zone 50

LOCATION

N

0 0.25 0.5
Kilometres

Government of Western Australia
Department of Water

FIGURE 2 BUSSELTON WATER'S SITES WITHIN WHICH THE BUSSELTON WATER RESERVES OCCUR

Figure 2 Proposed Busselton water reserves to occur within Busselton Water's sites no. 1, 2 3 and 5

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, good quality, aesthetically-acceptable drinking water to consumers.

Busselton Water monitors the quality of raw water at each bore site for health-related and aesthetic (non-health-related) characteristics (see Appendix A). This data indicates the quality of raw water from the aquifer. An assessment of drinking water quality supplied to consumers at Busselton is also made against the ADWG. This assessment is made by an intergovernmental committee called the Advisory Committee for the Purity of Water that is chaired by the Department of Health.

Busselton Water (2008c) notes that the raw groundwater has turbidity and total iron concentrations above the drinking water aesthetic guideline limits, which are removed by aeration and filtration processes at Busselton Water's treatment plants. The treated water meets accepted guidelines for public health before it is distributed to consumers.

3 Land use assessment

3.1 Potential water quality risks

Contamination risks to the Busselton water reserves are low because the water is drawn from a confined aquifer at depth. Nonetheless, proper bore construction and maintenance are required of existing bores and any new bores proposed to be located near drinking water production bores. This will prevent the bores from creating a contamination pathway between surface activities and the aquifer. All bores should be constructed in accordance with *Minimum construction requirements for water bores in Australia* (National Minimum Bore Specifications Committee 2003).

3.2 Existing land uses and activities

Production bores at Busselton are located on freehold Busselton Water land or crown reserve land vested with Busselton Water for the purpose of 'Water supply'. All reserves and freehold land are located within existing residential areas within the Busselton area (Figures 2 and 3). The eight production bores are situated within four of Busselton Water's operational water treatment plant sites. These sites, with the exception of site 5, also contain water treatment facilities and water storage tanks (refer to Figures B1 and B2).

Busselton Water's Drinking water source protection assessment (2008c) advises that the bores are confined and deep. Provided the wellheads remain sealed, current land uses should not pose a risk to water quality. The risk of contamination of this water source from land uses in the recharge area to the south is also considered low due to the long distance to the production bores and the storage capacity of the aquifer.

3.3 Proposed land uses and activities

Existing and future land-use planning decisions are not expected to be impacted by the Busselton water reserves given the confined nature of the aquifer and the depth of the production bores.

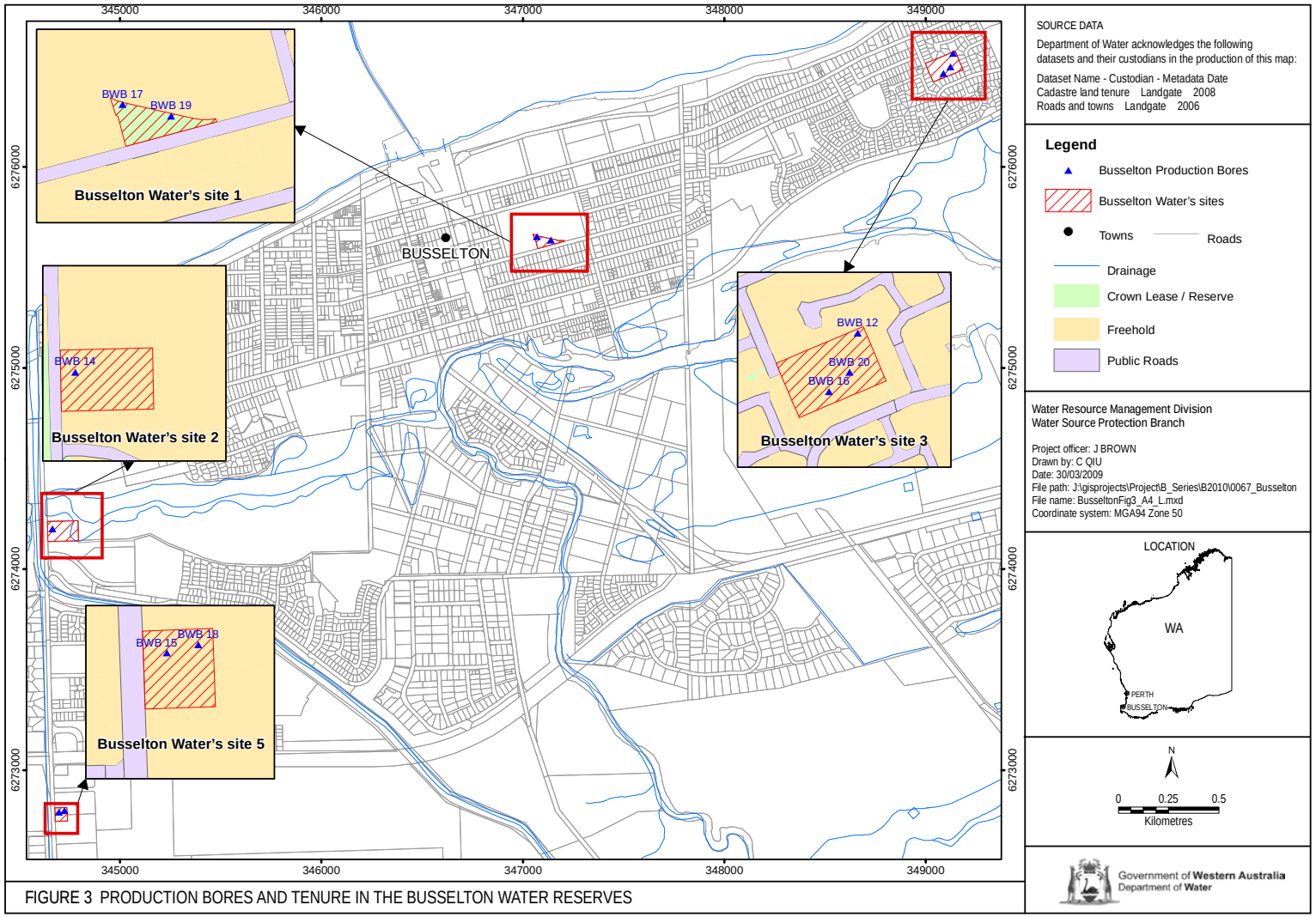


FIGURE 3 PRODUCTION BORES AND TENURE IN THE BUSSELTON WATER RESERVES

Figure 3 Production bore locations and tenure within Busselton Water's sites no. 1, 2, 3 and 5

4 Catchment protection strategy

4.1 Protection objectives

The objective of this plan is to protect Busselton's public drinking water source areas (PDWSAs) in order to ensure a reliable, safe drinking water is supplied to consumers.

4.2 Proclaimed area

Four sites (see sites no. 1, 2, 3 and 5, Figure 3) are to be proclaimed under the *Country Areas Water Supply Act 1947* to ensure their locations are formally recognised, and to trigger the creation of special control areas in the local planning scheme and related planning documents. Each of the sites is to be proclaimed to create the Busselton water reserves. Alternatively, a defined area around each production bore on these sites will be proclaimed to create the Busselton water reserves. A decision on which option is most appropriate will be made in consultation with Busselton Water.

4.3 Priority areas

Each of the Busselton water reserves will be assigned a Priority 1 (P1) classification once a decision on the size of the proclaimed area is made (see 4.2).

4.4 Land-use planning

It is recognised that under the *State planning strategy* (Western Australian Planning Commission 1997) 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 No. 2.7: Public drinking water source policy* (Western Australian Planning Commission 2003) it is appropriate that the Busselton water reserves and P1 areas be recognised in the *Shire of Busselton local planning scheme (*Shire of Busselton 2008).

4.5 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 will be encouraged to protect 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 *Minimum construction requirements for water bores in Australia* of the National Minimum Bore Specifications Committee 2003

For guidance regarding the construction, cement grouting and abandonment of bores also see the Department of Water Licensing and Industry support> Licensing> Publications and other documents listed in the *References* section of this document. The guidelines help managers reduce the water quality impacts of their operations and are recommended practice to ensure the protection of water quality.

Education and creating awareness (for example, signage and information) are also key mechanisms for protecting the quality of water, especially for people visiting the area who are unfamiliar with the Busselton water reserves. A brochure will be produced once this plan is endorsed, describing the Busselton water reserves, their locations and the main threats to water quality. This brochure will be available to the community and will inform people in simple terms of the drinking water source and the need to protect it.

4.6 Surveillance and by-law enforcement

The quality of water in PDWSAs within country areas of the state is protected under the *Country Areas Water Supply Act 1947*

Proclamation of the Busselton water reserves will allow existing and future by-laws to be applied to protect water quality.

5 Recommendations

The following recommendations apply to the Busselton water reserves. The bracketed stakeholders are those expected to have an interest in, or responsibility for, implementation of the relevant recommendation.

1 A suitable area around the eight existing production bores servicing Busselton, and any future drinking water bores, should be proclaimed under the *Country Areas Water Supply Act 1947* (*Department of Water and Busselton Water*).

2 The *Shire of Busselton local planning scheme* should reflect the identified Priority 1 areas and Busselton water reserves as special control areas in accordance with *Statement of Planning Policy No. 2.7: Public Drinking Water Source Policy* (*Shire of Busselton*).

3 Signs should be erected along the boundary of the Busselton water reserves to promote awareness of drinking water protection matters. Signs should include an emergency contact telephone number (*Busselton Water*).

4 Busselton Water's water monitoring program should continue to assess the ongoing quality of this drinking water source (*Busselton Water*).

5 Any bores proposed to be installed in close proximity to the Busselton water reserves should be assessed to determine their contamination risk to this water source (*Department of Water, bore owners*).

6 A review of this plan should be undertaken after five years (*Department of Water*).

Appendices

Appendix A— Water quality data

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

Water samples were collected each quarter from each production bore and submitted to a NATA approved lab for assessment (SGS laboratories). Additionally SGS laboratories outsource to Western Radiation Services analysis for radionuclide on an annual basis.

The analytical results of samples collected from bores for the period ending 1 June 2008 are presented in Table 1.

Most of the constituents analysed in the raw bore water, except for total iron, true colour, turbidity and, the occasionally, pH meet the health and aesthetic guidelines for drinking water (NHMRC and NRMMC, 2004). Treatment of the bore water by aeration and filtration at Plants 1, 2 and 3 ensures that water distributed through the water supply system complies with the drinking water guidelines.

Total iron concentrations in the water from all bores were found to be consistently above the aesthetic guideline value of 0.3mg/L, the exception being bore BWB 14 (lower Yarragadee aquifer), which has consistently resulted in iron concentrations at 0.10 mg/L or lower. BWB 19 (screened over the Leederville and upper Yarragadee aquifers) and BWB 18 (upper Yarragadee aquifer) consistently has the highest iron concentrations; ranging from 6.1 to 12.0mg/L.

Monitoring of BW bores consistently reveals that turbidity exceeds the aesthetic guideline value for drinking water of 5 Nephelometric Turbidity Units (NTU). Table 1 shows results form bores for the period ending 1 June 2008.

Chemical Composition	Plant 1		Plant 2	Plant 3			Plant 5		1987	1987	2004	2004
	BWB 17	BWB19[+]	BWB14	BWB12[+]	BWB16	BWB20	BWB15	BWB18	Maximum Health Guideline Value*	Maximum Aesthetic Guideline Value*	Maximum Health Guideline Value#	Maximum Aesthetic Guideline Value#
Major Ions (mg/L)												
Sodium	40	44	67	*40*	*38*	*150*	*48*	36		300		300
Potassium	18	18	24	*20*	*19*	*22*	*24*	15				
Calcium	23	17	20	*14*	*21*	*17*	*15*	8.7				
Magnesium	10	11	16	*8.7*	*11*	*11*	*12*	7.2				
Chloride	59	80	93	*64*	*61*	*170*	*75*	54		400		250
Sulphate	11	11	14	*12*	*12*	*24*	*12*	10		400	500	250
Bicarbonate	140	90	180	*130*	*170*	*220*	*170*	70				
Metals (mg/L)												
Aluminium	<0.02	<0.02	<0.02	*<0.02*	*<0.02*	*<0.02*	*<0.02*	<0.02		0.2		0.2
Arsenic	<0.002	<0.002	<0.002	*<0.002*	*<0.002*	*<0.002*	*<0.002*	<0.002	0.05		0.007	
Cadmium	<0.001	<0.001	<0.001	*<0.001*	*<0.001*	*<0.001*	*<0.001*	<0.001	0.005		0.002	
Chromium	<0.005	<0.005	<0.005	*<0.005*	*<0.005*	*<0.005*	*<0.005*	<0.005	0.05		0.05	
Copper	<0.005	<0.005	<0.005	*<0.005*	*<0.005*	*<0.005*	*<0.005*	<0.005		1		1
Mercury	<0.0005	<0.0005	<0.0005	*<0.0005*	*<0.0005*	*<0.0005*	*<0.0005*	<0.0005	0.001		0.001	
Manganese	0.068	0.060	0.02	*0.05*	*0.051*	*0.058*	*0.088*	0.033		0.1	0.5	0.1
Lead	<0.005	<0.005	<0.005	*<0.005*	*<0.005*	*<0.005*	*<0.005*	<0.005	0.05		0.01	
Selenium	<0.003	<0.003	<0.003	*<0.003*	*<0.003*	*<0.003*	*<0.003*	<0.003	0.01		0.01	
Zinc	0.02	0.12	0.011	*0.037*	*0.047*	*0.03*	*0.037*	0.029		5		3
Other Inorganic Parameters (mg/L)												
Iron (Total)	1.50	12.0	0.10	*5.0*	*2.60*	*0.40*	*0.60*	9.5		0.3		0.3
Nitrate	<0.2	<0.2	<0.2	*<0.2*	*<0.2*	*<0.2*	*<0.2*	<0.2	10		50	
Fluoride[1]	<0.1	0.4	0.6	*0.6*	*0.5*	*1.5*	*0.5*	0.5	0.5 to 1.7		1.5	
Silica, SiO_2	16	17	16	*15*	*14*	*13*	*13*	18				
Cyanide (Total)	<0.01	<0.01	<0.01	*<0.01*	*<0.01*	*<0.01*	*<0.01*	<0.01	0.1		0.08	
Physical and Chemical Characteristics												
pH	8.0	7.4	8.3	*7.4*	*7.6*	*8.0*	*7.7*	7.4		6.5 - 8.5		6.5 - 8.5
EC @ 25°C (µS/cm)	440	460	610	*430*	*480*	*940*	*510*	340				
TDS (mg/L) (grav)	250	240	320	*220*	*230*	*450*	*250*	200		1000		500
Total Alkalinity as $CaCO_3$ (mg/L)	120	73	150	*100*	*140*	*180*	*140*	58				
True Colour (PCU)	<5	<5	<5	*<5*	*<5*	*<5*	*<5*	<5		15		15
Hardness as $CaCO_3$ (mg/L)	100	89	110	*72*	*100*	*89*	*85*	51		500		200
Turbidity (NTU)	13	30	<1	*30*	*23*	*3*	*8*	16		5		5

italics = results from March 2008 analyses
TDS = Total Dissolved Solids
mg/L = milligrams per Litre
µS/cm = micro-Siemens per centimetre
N.T.U. = Nephelometric Turbidity Units
PCU = Platinum - Cobalt Units
* NHMRC AWRC (1987)
[#] NHMRC and NRMMC (2004)
[1] Target range of fluoride 0.5 - 1.7 mg/L (temperature dependent).
[+] Leederville Aquifer

Table 1: Chemical Analyses of Bore Water (Period ending 1 June 2008)

Appendix B— Photographs

Figure B1 Water treatment plant 2 of Busselton Water (photo: Landgate)

Figure B2 Bore BWB 14 at treatment plant 2 (photo: Busselton Water)

List of shortened forms

ADWG	Australian drinking water guidelines
AHD	Australian height datum
ANZECC	Australian and New Zealand Environment Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
CFU	colony forming units
EC	electrical conductivity
GL	gigalitre
HAZMAT	hazardous materials
kL	kilolitre
km^2	square kilometre (a measure of area) = one million square metres
mg/L	milligram per litre
mL	millilitre
ML	megalitre
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 No. 88
PDWSA	public drinking water source area
TCU	true colour units (a measure of degree of colour in water)
TDS	total dissolved solids
TFSS	total filterable solids by summation
WHPZ	wellhead protection zone

Glossary

Abstraction	The pumping of groundwater from an aquifer, or the removal of water from a waterway or water body.
ADWG	Australian drinking water guidelines, outlining acceptable criteria for the quality of drinking water in Australia.
Aesthetic guideline	A water quality criteria in the Australian drinking water guidelines associated with acceptability of water to the consumer, for example, appearance, taste and odour (NHMRC & NRMMC, 2004a).
AHD	Australian Height Datum is the height of land in metres above mean sea level. For example, AHD is +0.026 m at Fremantle.
Allocation	The quantity of water permitted to be abstracted by a licensee, usually specified in kilolitres per annum (kL/a).
Anisotropic	Having different properties in different directions.
Aquifer	A geological formation or group of formations able to receive, store and transmit significant quantities of water.
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.
Colony forming units (CFU)	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.
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 °Celsius. Measurement units include milliSiemens per metre and microSiemens per centimetre.
Gigalitre	A gigalitre is equivalent to 1 000 000 000 litres or one million

	kilolitres.
Health guideline value	A water quality criterion in the Australian drinking water guidelines associated with human health that, based on present knowledge, does not result in any significant risk to the consumer over a lifetime of consumption (NHMRC & NRMMC 2004).
Hydrocarbons	A class of compounds containing only hydrogen and carbon, such as methane, ethylene, acetylene and benzene. Fossil fuels such as oil, petroleum and natural gas all contain hydrocarbons.
Hydrogeology	The study of groundwater, especially relating to the distribution of aquifers, groundwater flow and groundwater quality.
mg/L	Milligram per litre (0.001 grams per litre) as a measurement of a total dissolved solid in a solution.
mL	Millilitre
ML	Megalitre (1 000 000 litres = one million litres).
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.
NTU	Nephelometric turbidity units are a measure of turbidity in water.
Pathogen	A disease producing organism that can cause sickness and sometimes death through the consumption of water, including bacteria (such as *Escherichia coli*), protozoa (such as *Cryptosporidium* and *Giardia*) and viruses.
pH	A logarithmic scale for expressing the acidity or alkalinity of a solution. A pH below seven indicates an acidic solution and above seven indicates an alkaline solution.
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.
Production bore	A bore supplying public drinking water (see also ‘bore’ and ‘well field’).
Public sector	A state government circular produced by the Department of Health

circular No. 88 (PSC 88)	providing guidance on appropriate herbicide use within water catchment areas.
Public drinking water source area (PDWSA)	Includes all underground water pollution control areas, catchment areas and water reserves constituted under the *Metropolitan Water Supply Sewerage and Drainage Act 1909* and the *Country Areas Water Supply Act 1947*.
Recharge	Water infiltrating through soil/ground to replenish an aquifer.
Recharge area	An area through which water from a groundwater catchment percolates to replenish (recharge) an aquifer. An unconfined aquifer is recharged by rainfall throughout its distribution. Confined aquifers are recharged in specific areas where water leaks from overlying aquifers, or where the aquifer rises to meet the surface.
Reservoir Protection Zone (RPZ)	A buffer measured from the high water mark of a drinking water reservoir, and inclusive of the reservoir (usually 2 km). This is referred to as a 'Prohibited Zone' under the *Metropolitan Water Supply, Sewerage and Drainage Act By-laws 1981.*
Runoff	Water that flows over the surface from a catchment area, including streams.
TDS	Total dissolved solids consist of inorganic salts and small amounts of organic matter that are dissolved in water. Clay particles, colloidal iron and manganese oxides and silica fine enough to pass through a 0.45 micrometer filter membrane can also contribute to total dissolved solids. Total dissolved solids comprise sodium, potassium, calcium, magnesium, chloride, sulfate, bicarbonate, carbonate, silica, organic matter, fluoride, iron, manganese, nitrate (and nitrite) and phosphate (NHMRC & NRMMC 2004a).
Treatment	Application of techniques such as settlement, filtration and chlorination to render water suitable for specific purposes, including drinking and discharge to the environment.
Turbidity	The cloudiness or haziness of water caused by the presence of fine suspended matter.
Unconfined aquifer	An aquifer in which the upper surface of water is lower than the top of the aquifer itself. The upper surface of the groundwater within the aquifer is called 'the watertable'.
Water quality	The physical, chemical and biological properties of water.

Water reserve	An area proclaimed under the *Country Areas Water Supply Act 1947* or the *Metropolitan Water Supply Sewerage and Drainage Act 1909* for the purposes of protecting a drinking water supply.
Watertable	The upper saturated level of the unconfined groundwater.
Well field	A group of bores to monitor or withdraw groundwater.
Wellhead	The top of a well (or bore) used to draw groundwater.
Wellhead protection zone (WHPZ)	A wellhead protection zone (WHPZ) is usually declared around wellheads in drinking water areas to protect the water source from immediate contamination threats in the nearby area.

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