Government of **Western Australia**
Department of **Water and Environmental Regulation**

Mingenew Water Reserve

drinking water source protection review

Mingenew town water supply

Water resource protection series
Report WRP 168
October 2017

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Cover photograph: Aerial photo of Mingenew Water Reserve

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Summary

This report was prepared by the former Department of Water. On 1 July 2017, the Government of Western Australia established the Department of Water and Environmental Regulation, resulting from the amalgamation of the Department of Water, the Department of Environment Regulation and the Office of the Environmental Protection Authority. As such, this publication contains references to previous government departments and programs. Please email drinkingwater@dwer.wa.gov.au to clarify any specific information.

This drinking water source protection review considers changes that have occurred in the Mingenew Water Reserve since completion of the *Mingenew Water Reserve water source protection plan* (Waters and Rivers Commission 2001). This review and the 2001 plan should be read together, and they are both available on our website or by contacting us.

Mingenew is located about 400 km north of Perth (Figure A1). It is the administrative centre for the Shire of Mingenew, providing services for local activities including broadacre farming and tourism.

The Mingenew town water supply comes from four Water Corporation bores located south of the town in the Mingenew Water Reserve. The bores abstract water from a shallow, semi-confined aquifer within the Parmelia Formation. This groundwater source is considered vulnerable to contamination from surface-based activities occurring within the reserve including farming and waste disposal. The Mingenew Water Reserve was proclaimed in 1983 under the *Country Areas Water Supply Act 1947*. It is a Priority 2 (P2) area.

We prepared this review in consultation with land owners, the Water Corporation and the Shire of Mingenew.

The main changes since the 2001 plan are:

- production bore 13 is no longer in use
- a new production bore (1/13) has been developed. To protect it, a 300 m wellhead protection zone has been assigned.

This review does not propose any changes to the existing water reserve boundary or the P2 area. Key information about the Mingenew Water Reserve is provided in Table 1.

This review is consistent with the *Australian drinking water guidelines* (ADWG; NHMRC & NRMMC 2011) and State planning policy no. 2.7: *Public drinking water source policy.*

Table 1 Key information about the Mingenew Water Reserve

Mingenew Water Reserve	
Status of this report	This report has been prepared based on information for the 2014/15 financial year
Location supplied	Mingenew
Water service provider	Water Corporation
Aquifer type	Shallow, semi-confined (vulnerable to surface-based contamination)
Licensed abstraction	Water Corporation is licenced by the Department of Water and Environmental Regulation under groundwater licence GWL 65319(6) for 120 000 kL/year
Bore name (GPS coordinates) Screen slot interval and depth (m below top of casing)	1/13 (E 348557, N 6768539) 30.00–36.00; 39.00 5/86 (E 348548, N 6768786) 28.40–40.20; 40.40 3/87 (E 349182, N 6766933) 31.10–43.10; 40.40 1/78 (E 349640, N 6767022) 16.31–33.96; 33.96 13 (E 348405, N 6768779) 30.70–37.00; 37.80 (offline)
Dates of drinking water source protection reports	2001 – *Mingenew Water Reserve water source protection plan* (Water and Rivers Commission) 2016 – *Mingenew Water Reserve drinking water source protection review* (this document)
Consultation	2001 – advertised public consultation as part of the water source protection plan 2015 – consultation with landholders, government agencies and the Shire of Mingenew
Proclamation status	Proclaimed as Mingenew Water Reserve on 22/11/1983 under the *Country Areas Water Supply Act 1947*. This review does not propose any boundary changes.
Primary reference documents	*Mingenew Water Reserve water source protection plan* (Waters and Rivers Commission 2001) *Mingenew town water scheme water resource management operation strategy* (Water Corporation 2014)

1 Review of Mingenew's drinking water source protection plan

1.1 Boundary, priority areas and protection zones

Since the *Mingenew Water Source Protection Plan* (Water and Rivers Commission 2001) there have been no changes to the Mingenew Water Reserve boundary or priority areas (Figure A2). However, the wellhead protection zones have been updated to reflect the current location of production bores. Bore 1/13 was drilled in 2013. A 300 m wellhead protection zone has been placed around this bore (Figure A2). This bore replaces bore 13 which was taken offline in 2012 due to water quality issues. The associated 300 m wellhead protection zone around this bore was also removed. The Mingenew Water Reserve will remain a priority 2 (P2) area.

A hydrogeological assessment of the Mingenew Water Reserve area is scheduled before the next update of this review. This is consistent with the Department of Water and Environmental Regulation's program of boundary reviews being undertaken for drinking water sources using current data and modelling techniques. If required, updates to priority areas and protection zones will be made at this time.

If you require more information about how we protect drinking water sources, please read Appendix E.

2 Review of Mingenew's drinking water source protection plan

2.1 Boundary, priority areas and protection zones

Since the *Mingenew Water Source Protection Plan* (Water and Rivers Commission 2001) there have been no changes to the Mingenew Water Reserve boundary or priority areas (Figure A2). However, the wellhead protection zones have been updated to reflect the current location of production bores. Bore 1/13 was drilled in 2013. A 300 m wellhead protection zone has been placed around this bore (Figure A2). This bore replaces bore 13 which was taken offline in 2012 due to water quality issues. The associated 300 m wellhead protection zone around this bore was also removed. The Mingenew Water Reserve will remain a priority 2 (P2) area.

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If you require more information about how we protect drinking water sources, please read Appendix E.

2.2 Update on water supply scheme

The Department of Water and Environmental Regulation licenses the Water Corporation to abstract 120 000 kL of groundwater per year from the semi-confined Parmelia aquifer to supply drinking water to Mingenew (groundwater licence 65319(6)). There are currently 200 units to supply. The current demand for water is being met and is predicted to remain stable.

The Mingenew Water Reserve bore field consists of four production bores (figures A2 and A3). The northern bores (1/13 and 5/86) are located about 1 km south of Mingenew in the northern part of the water reserve. The new bore 1/13 replaces bore 13. The southern bores (1/78 and 3/87) are located about 3.5 km south of town in the centre of the water reserve.

A groundwater treatment plant is located in the Mingenew Water Reserve on Crown land, close to the northern bores (5/86 and 1/13). These two bores pump water directly to the treatment plant. The southern bores (3/87 and 1/78) pump water to a nearby storage tank. From there, water is gravity fed to the treatment plant where it is chlorinated for disinfection and aerated for iron oxidation before entering two storage tanks. Treated water is then gravity fed to consumers via the Mingenew reticulation system (R Carruthers 2015, pers. comm., 07 May)

It should be recognised that although treatment and disinfection are essential barriers against contamination, public drinking water source area (PDWSA) management is

the first step in protecting water quality and ensuring a safe drinking water supply. This approach is endorsed by the *Australian drinking water guidelines* (ADWG; NHMRC & NRMMC 2011) and reflects an approach based on preventive risk and multiple barriers for providing safe drinking water to consumers. This combination of catchment protection and water treatment will deliver a more reliable, safer and lower cost drinking water to consumers than either approach could achieve individually.

For more information on why it is so important to protect our catchments, read Appendix E.

2.3 Aboriginal native title claims

Native title is the recognition in Australian law that some Aboriginal people continue to hold native title rights to lands and water arising from their traditional laws and customs. There are three native title claims in the Mingenew Water Reserve. These are the Widi Mob (WAD6193_1998), the Amangu people (WAD6002_2004) and the Mullewa Wadjari Community (WAD6119_1998).

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

2.4 Enforcing by-laws, surveying the area and maintenance

This review recommends that the Water Corporation continues surveillance and by-law enforcement under the existing delegation arrangement. This includes:

- erecting and maintaining drinking water source protection signage
- maintaining fencing around the production bores and treatment infrastructure
- ongoing surveillance and inspections.

2.5 Other department work

The former Department of Water published other documents about water information in the Mingenew area. These should be used in conjunction with this document to guide the management of groundwater sources in the Mingenew area.

The *Arrowsmith groundwater area allocation plan* (Department of Water 2010) provides the department's direction for managing groundwater use in the Arrowsmith groundwater area. The Arrowsmith groundwater area is divided into the Allanooka, Darling, Dongara, Eneabba Plains, Mingenew, Morrison, Tathra and Twin Hills subareas.

The department completed the *Mid West regional water supply strategy: A long-term outlook of water demand and supply* in April 2015. The strategy considers a range of water demand scenarios for mining, industry, agriculture and towns in the region and identifies water supply options to meet demand well into the future.

2.6 Update on water quality risks

As part of this review the former Department of Water conducted a new assessment of water quality contamination risks to Mingenew's drinking water source, in accordance with the ADWG. Table 3 summarises the potential water quality contamination risks.

Land uses and activities occurring in the Mingenew Water Reserve have not changed much since the 2001 plan (Figure A3). Broadacre farming (grazing and cropping) occurs over a large proportion of the water reserve. In addition, land is used for recreation, roads, conservation and water supply purposes. Photographs C1 to C9 show various land uses within the Mingenew Water Reserve. These land uses pose some risks to water quality but the risks can be minimised and managed by using best management practices. The Mingenew townsite is located directly to the north of the Mingenew Water Reserve

A waste transfer station, formally a landfill site, continues to operate within the Mingenew Water Reserve. Located close to the southern bores and upgradient of the northern bores, it continues to pose a risk to groundwater quality. In 2007, this site was placed on the former Department of Environment Regulation's contaminated sites database and classified as 'possibly contaminated – investigation required'. Such investigation will be required to understand the full nature of any contamination present, including risk to the groundwater resource.

Bore 13 has been taken offline permanently due to cracked headworks and microbiological contamination. This bore is located on farmland where livestock are grazed. This review recommends decommissioning bore 13 in accordance with national standards (National Uniform Drillers Licensing Committee 2012) to prevent any further risk of groundwater contamination via ingress through this bore.

Refer to Appendix D for information about typical contamination risks in PDWSAs and Appendix F to gain a greater understanding about the risk assessment process we use.

1.6.1 Other groundwater bores

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

It is therefore important to ensure that any bores are appropriately located and constructed to prevent contamination of the public drinking water source. This will be assessed through Department of Water and Environmental Regulation's water licensing process where applicable under the *Rights in Water and Irrigation Act 1914.* All bores should be constructed in accordance with *Minimum construction requirements for water bores in Australia* (National Uniform Drillers Licensing Committee 2012).

In the Mingenew Water Reserve, there are six licensed water users within a kilometre of the Water Corporation production bores. Additionally, various landholders may be taking groundwater for stock and domestic purposes only, with no licensing requirement.

Table 2 Summary of potential water quality risks, land use compatibility and best management practices

Land use/activity	Hazard	Management priority	Comments	Best management practice guidance[1]
Roads and tracks	Hydrocarbons Chemical spills	Low	Compatible with conditions Unsealed roads and tracks should be minimised Roads and tracks should be maintained	WQPN no. 44: *Roads near sensitive water resources* WQPN no.10: *Contaminant spills emergency response*
Broadacre cropping and grazing	Chemicals Nutrients Pathogens Hydrocarbons	Medium	Compatible with conditions in P2 areas Large proportion of land within reserve is private farms Cropping/grazing occurs close to production bores Bore 13, located on private farmland, has been taken offline but has not been decommissioned	WQPN no. 1: *Agriculture dryland crops near sensitive water resources* WQPN no. 48: *Water supplies for rural lots non potable use* WQPN No. 80: *Stockyards* WQPN No. 104: *Aerial spraying of crops with pesticides*
Waste transfer station	Hydrocarbons Nutrients Pathogens Chemicals	High	Existing, incompatible land use Close to southern bores and in flow path of northern production bores Built on former landfill site Listed as 'possibly contaminated- investigation required' on Department of Water and Environmental Regulation's contaminated sites database – groundwater investigations are	WQPN no. 52: *Stormwater management at industrial sites* WQPN no. 30 *Groundwater monitoring bores* WQPN no.111: *Landfills for disposal of putrescible materials*

Land use/activity	Hazard	Management priority	Comments	Best management practice guidance[1]
			required to determine extent of any contamination Listed as a controlled waste disposal site by Department of Water and Environment Regulation but no licence is required Dumping of unauthorised waste has occurred in the past and may occur again	*Guide to best management practice at resource recovery centres* (Sustainability Victoria 2009)
Recreation and community purpose reserves	Pathogens Nutrients Chemicals Hydrocarbons	Low–Medium	Compatible with conditions Located over Crown land, including golf course, sporting ovals, racecourse, showgrounds, passive walk trails, airstrip, rifle range, community buildings and remnant bushland Showgrounds hold two major events each year, disabled toilets are permanent, temporary ablutions are brought in for events Sporting grounds are irrigated seasonally Air strip and rifle range are not currently used	WQPN no. 33: *Nutrient and irrigation management plans* WQPN no. 65: *Toxic and hazardous substance storage and use* Operational policy 13: *Recreation within public drinking water source areas on Crown land*
Drinking water infrastructure – treatment	Chemicals	Low	Compatible with conditions	WQPN no. 52: *Stormwater management at industrial sites* WQPN no. 51: *Industrial wastewater management and disposal*

Land use/activity	Hazard	Management priority	Comments	Best management practice guidance[1]
plant, bores etc.				*Minimum construction requirements for water bores in Australia* (National Uniform Drillers Licensing Committee 2012) WQPN no. 65: *Toxic and hazardous substance storage and use*
Conservation reserves	Hydrocarbons Chemicals Pathogens Nutrients	Low	Department of Biodiversity, Conservation and Attractions manage bushland Reserve 428 for conservation purposes Reserve 24083 (adjacent) is not currently vested with an authority but has been set aside for conservation purposes in the town planning scheme Hunting, free camping, bushwalking etc. may occur creating a pathogen risk	WQPN no. 96: *Pest animal management in public drinking water source areas* Operational policy 13: *Recreation within public drinking water source areas on Crown land*

[1] *Water quality protection notes (WQPNs) are available www.water.wa.gov.au or see Further reading*

.

2.7 Water quality information

The Water Corporation has provided updated water quality information for the Mingenew source. This is shown in Appendix B.

In some cases, aesthetic guideline values in the ADWG are being exceeded in raw water from the Mingenew Water Reserve bores. The higher concentrations of salts, iron and turbidity are most likely from natural sources and the water undergoes treatment to rectify this before being supplied to consumers. The water has met all the ADWG's health guideline values.

Water from the Mingenew Water Reserve is tested and treated to make sure it is safe to drink before it is provided to consumers.

3 Implementation of Mingenew's drinking water source protection plan

3.1 Status of previous recommendations

Table 3 outlines recommendations from the 2001 plan and their current status.

Table 3 Implementation status for Mingenew Water Reserve

No.	Recommendation	Comments
1	Incorporate Mingenew Water Reserve boundary into local government land planning strategies.	The Mingenew Water Reserve has been incorporated in the Shire of Mingenew's Local Planning Scheme No 3 (last updated July 2015).
2	Referral of development proposals which are likely to impact on water quality.	Development proposals within the Mingenew Water Reserve are referred to the Mid-West Gascoyne office of the Department of Water and Environmental Regulation. This has been continued as a recommendation of this review (recommendation 1; section 2.2).
3	Erect signs along boundary of Mingenew Water Reserve and wellhead protection zones to define the area to the public.	Signs advising of the location of the Mingenew Water Reserve are in place. Many are in need of replacement. Sign maintenance has been continued as a recommendation of this review (see recommendation 3; section 2.2).
4	Develop and implement an environmental guideline for broad hectare agriculture.	WQPN no.1 *Agriculture: dryland crops near sensitive water resources* and WQPN no. 35: *Pastoral stations within rangelands* were published by the former Department of Water in 2006. The best management practices outlined in the WQPN no. 35 could also be applied to non-pastoral lease farms with extensive grazing practices.

No.	Recommendation	Comments
5	Establish a surveillance program to identify any incompatible land uses or potential contaminant threats within the water reserve. Surveillance and by law enforcement responsibility should be delegated to the Water Corporation.	Water Corporation has delegated responsibility for this and undertakes regular surveillance within the Mingenew Water Reserve. This has been continued as a recommendation of this review (recommendation 3; section 2.2).
6	Emergency response: • Develop response plan. • Inform Westplan–HAZMAT personnel of special requirements for the Mingenew Water Reserve.	This has been done and has been continued as a recommendation of this review (recommendation 2; section 2.2).
7.	Water Corporation to monitor groundwater quality.	Water Corporation monitors and reviews production bore water data (both raw and reticulated water) on a regular basis to ensure water quality issues and adverse trends are detected and rectified. This will be continued as a recommendation of this review (recommendation 3; section 2.2)
8.	Waste transfer station • Review Department of Environmental Protection licence conditions to ensure risks to groundwater quality are addressed • Investigate opportunities to relocate facility	The former Department of Environmental Protection, (now the Department of Water and Environmental Regulation), advised that the facility is no longer licensed as the amount and type of rubbish received on site falls outside of licensing requirements. The site is listed as 'possibly contaminated' on the contamination sites database. This review recommends testing be undertaken to identify any environmental contamination (recommendation 5; section 2.2). The shire has advised that opportunities are still being investigated to relocate the facility. This will be continued as a recommendation of this review (recommendation 4; section 2.2).
9.	Review of the 2001 plan and recommendations.	Completed through the preparation of this review document.

3.2 Consolidated recommendations

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

1. Refer development proposals within the Mingenew Water Reserve that are inconsistent with Departmental of Water and Environmental Regulation policy (such as WQPN no. 25: *Land use compatibility tables for public drinking water source areas*; Operational policy 13: *recreation within public drinking water source areas on Crown land*) or recommendations made in this review. These should be referred to the department's Midwest Gascoyne office for advice. (Department of Planning, Lands and Heritage, Shire of Mingenew, Department of Biodiversity, Conservation and Attractions, proponents)
2. Ensure incidents covered by Westplan–HAZMAT in the Mingenew Water Reserve are addressed by ensuring that:
    - the Midwest Gascoyne Emergency Management District is aware of the location and purpose of the Mingenew Water Reserve
    - the locality plan for the Mingenew Water Reserve is provided to the Department of Fire and Emergency Services headquarters for the HAZMAT emergency advisory team
    - the Water Corporation acts in an advisory role during incidents in the Mingenew Water Reserve
    - personnel dealing with Westplan–HAZMAT incidents in the area have ready access to a locality map of the Mingenew Water Reserve and information to help them recognise the potential impacts of spills on drinking water quality.

    (Department of Water and Environmental Regulation, Water Corporation, Midwest Gascoyne Emergency Management District)
3. Water Corporation to continue the current regime of water quality monitoring, fencing and signage maintenance, inspections and by-law enforcement. (Water Corporation)
4. Investigate opportunities to relocate the waste transfer station, preferably outside of the Mingenew Water Reserve. (Shire of Mingenew)
5. Investigate the extent of any groundwater contamination at the waste transfer station, former landfill site. (Shire of Mingenew, Department of Water and Environmental Regulation)
6. Undertake a hydrogeological assessment of the Mingenew area for the next report on the Mingenew Water Reserve. (Department of Water and Environmental Regulation)
7. Bore 13 to be decommissioned, as per national industry standard. (Water Corporation)

8. Update this review within seven years. (Department of Water and Environmental Regulation)

4 Consultation

4.1 Stakeholder consultation process

Key stakeholders including private landholders, former Department of Parks and Wildlife, Yamatji Marlpa Aboriginal Corporation, Water Corporation and the Shire of Mingenew, were consulted about this review. Stakeholders were advised of the purpose of the review, known changes and asked to provide any feedback or information that may be useful to complete the review. Correspondence occurred via phone, email and letter.

4.2 Key issues raised in consultation

The following table provides a summary of the key issues raised during consultation of the *Mingenew Water Reserve drinking water source protection review*. Individual stakeholders have not been identified in order to protect their privacy. Issues that were not related to this review have not been listed, but have been explained or resolved directly with the affected stakeholder(s).

Table 4 Key issues raised during consultation for Mingenew Water Reserve

Issue raised	**Response**
Concern that a water reserve over private land will result in having to cease farming practices.	The Mingenew Water Reserve is existing and the boundary and priority areas remain unchanged. There will be no impact on broadacre farming practices as the land will remain a priority 2 (P2) area. P2 land is managed to ensure that there is no increased risk of water source contamination. The guiding principle in P2 areas is risk minimisation. Broadacre cropping and stock grazing are considered compatible with conditions in P2 areas. Department of Water and Environmental Regulation expects that landowners continue to use best management practices, such as those outlined in Table 2, to protect water quality in this area.
Concern that a new WHPZ could affect farming practices.	As above, but with emphasis on best management practice, given the location within WHPZs.
Questions regarding how the Mingenew Water Reserve boundary was developed.	The Mingenew Water Reserve boundary is based on the known groundwater recharge area for the production bores and follows cadastral boundaries for simplicity. This area will be reviewed during a future update of this report.

Issue raised	Response
Concerns about the Mingenew waste transfer station as a potential contamination threat to nearby groundwater production bores.	This operation is an existing practice within the Mingenew Water Reserve and is therefore allowed to continue, even though it is incompatible. The department encourages the use of best practice to manage and minimise risks to groundwater. The site is registered as a 'possibly contaminated-investigations required' site with the Department of Water and Environmental Regulation. The department encourages the shire to investigate relocating the facility to a site with less risk and to investigate groundwater quality risks from the historic landfill at the same site (see section 2.2 for recommendations).

Appendices

Appendix A — Figures

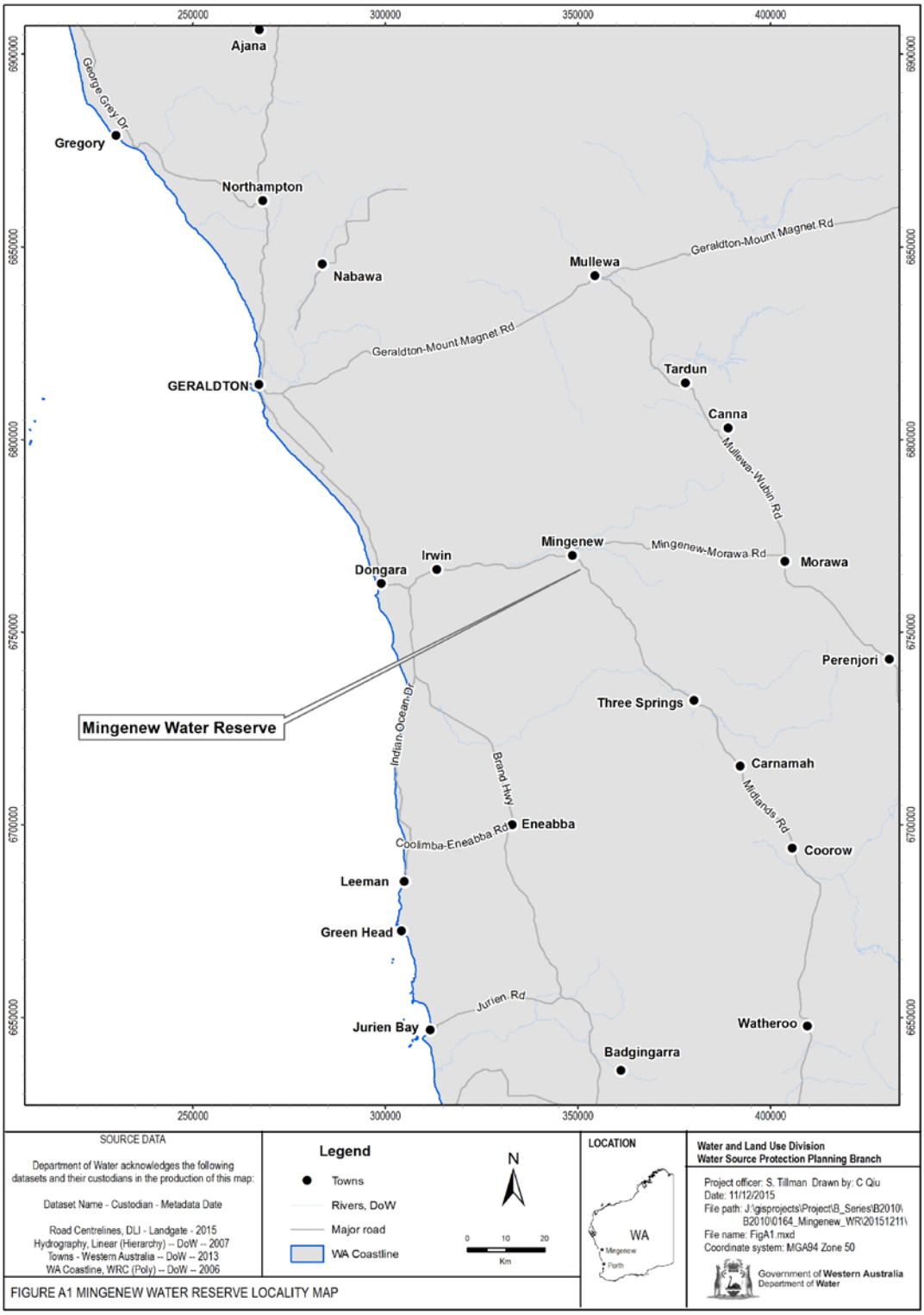

FIGURE A1 MINGENEW WATER RESERVE LOCALITY MAP

Figure A1 Mingenew Water Reserve locality map

Figure A2 Mingenew Water Reserve, boundary, priority areas and wellhead protection zones

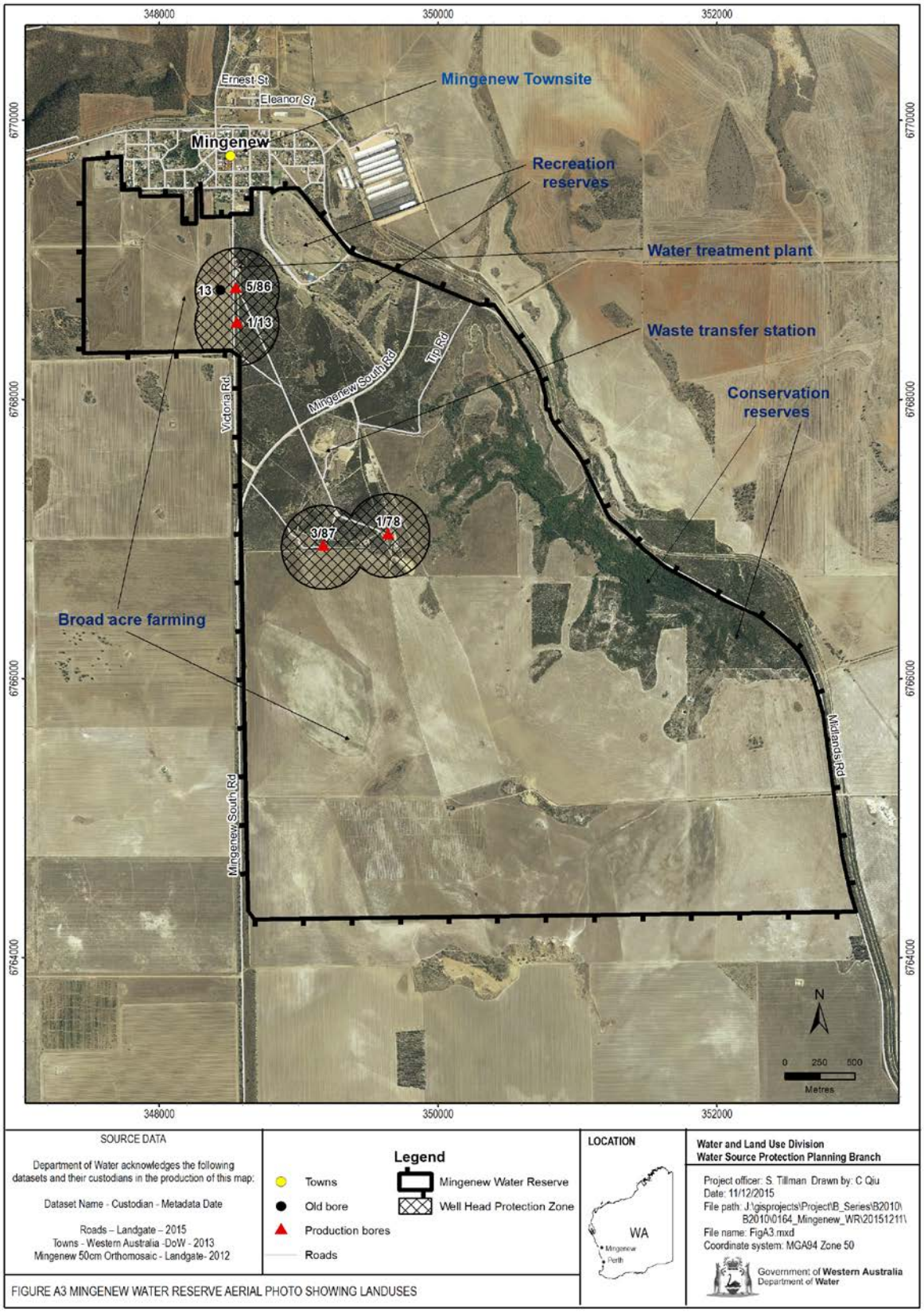

Figure A3 Mingenew Water Reserve aerial photo showing land uses

Appendix B — Water quality data

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

The Water Corporation has monitored the raw (source) water quality from Mingenew Water Reserve in accordance with the requirements of the *Australian drinking water guidelines* (ADWG; NHMRC & NRMMC 2011) and interpretations agreed to with the Department of Health. This data shows the quality of water in the public drinking water source area (PDWSA). The raw water is monitored regularly for:

- aesthetic characteristics (non-health-related)
- health-related characteristics including:
  - health-related chemicals
  - microbiological contaminants.

The following data represents the quality of raw water from Mingenew bore field. In the absence of specific guidelines for raw-water quality, the results have been compared with the ADWG values set for drinking water, which defines the quality requirements at the customer's tap. Any water quality parameters that have been detected are reported; those that on occasion have exceeded the ADWG are in ***bold and italics*** to give an indication of potential raw-water quality issues associated with this source. The values are taken from ongoing monitoring for the period May 2010 to April 2015.

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

For more information on the quality of drinking water supplied to Mingenew refer to the most recent Water Corporation drinking water quality annual report at www.watercorporation.com.au.

Aesthetic characteristics

The aesthetic quality analyses for raw water from Mingenew bore field are summarised in the following table.

Aesthetic detections for Mingenew bore field

Parameter	**Units**	**ADWG aesthetic guideline value***	**Mingenew bore field raw source**	
			Range	**Median**
Chloride	mg/L	250	***285–360***	***340***
Copper	mg/L	1	0.01–0.025	0.0175

Parameter	Units	ADWG aesthetic guideline value*	Mingenew bore field raw source	
			Range	Median
Hardness as $CaCO_3$	mg/L	200	56–83	76
Iron unfiltered	mg/L	0.3	<0.003–***3.6***	0.03
Manganese unfiltered	mg/L	0.1	<0.002–0.035	0.003
Silicon as SiO_2	mg/L	80	50–60	55
Sodium	mg/L	180	***185–225***	***200***
Sulfate	mg/L	250	30–42	31.5
Total filterable solids by summation	mg/L	500	***616–741***	***685.5***
Turbidity	NTU	5	<0.1–***11***	0.2
pH (lab measured)	no units	6.5–8.5	5.93–7.07	6.35

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

Health-related chemicals

Raw water from Mingenew bore field is analysed for chemicals that are harmful to human health, including inorganics, heavy metals, industrial hydrocarbons and pesticides. Health-related parameters that have been detected in the source are summarised in the following table.

Health-related detections for Mingenew bore field

Parameter	Units	ADWG health guideline value*	Mingenew bore field raw source	
			Range	Median
Annual radiation dose	mSv	1	0.092–0.092	0.092
Barium	mg/L	0.7	0.07–0.17	0.12
Boron	mg/L	4	0.14–0.2	0.18
Copper	mg/L	2	0.01–0.025	0.0175

Parameter	Units	ADWG health guideline value*	Mingenew bore field raw source	
			Range	Median
Fluoride (lab measured)	mg/L	1.5	0.1–0.2	0.15
Manganese unfiltered	mg/L	0.5	<0.002–0.035	0.003
Nickel	mg/L	0.02	0.002–0.004	0.003
Radon-222	Bq/L	100	4.8–4.8	4.8
Selenium	mg/L	0.01	<0.003–0.003	<0.003
Sulfate	mg/L	500	30–42	31.5

** 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 & NRMMC 2004).*

† A guideline value of 11.29 mg/L (as nitrogen) has been set to protect bottle-fed infants less than three months of age. Up to 22.58 mg/L (as nitrogen) can be safely consumed by adults and children over three months of age.

Microbiological contaminants

Microbiological testing of raw-water samples from Mingenew bore field is currently conducted on a monthly basis. *Escherichia coli* counts are used as an indicator of the degree of recent faecal contamination of the raw water from warm-blooded animals.

A detection of *E. coli* in raw water may indicate contamination of faecal material.

During the reviewed period, positive *E. coli* counts were recorded in 6.2 per cent of samples. Of these, none had *E. coli* counts greater than 20 MPN/100mL.

Appendix C — Photographs

Figure C1 Mingenew waste transfer station sign, photograph by M. Sawyer, Water Corporation

Figure C2 Mingenew groundwater collector (storage) tank in the south of the reserve, photograph by M. Sawyer, Water Corporation

Figure C3 Roads and tracks in the Mingenew Water Reserve. Erosion is common, photograph by M. Sawyer, Water Corporation

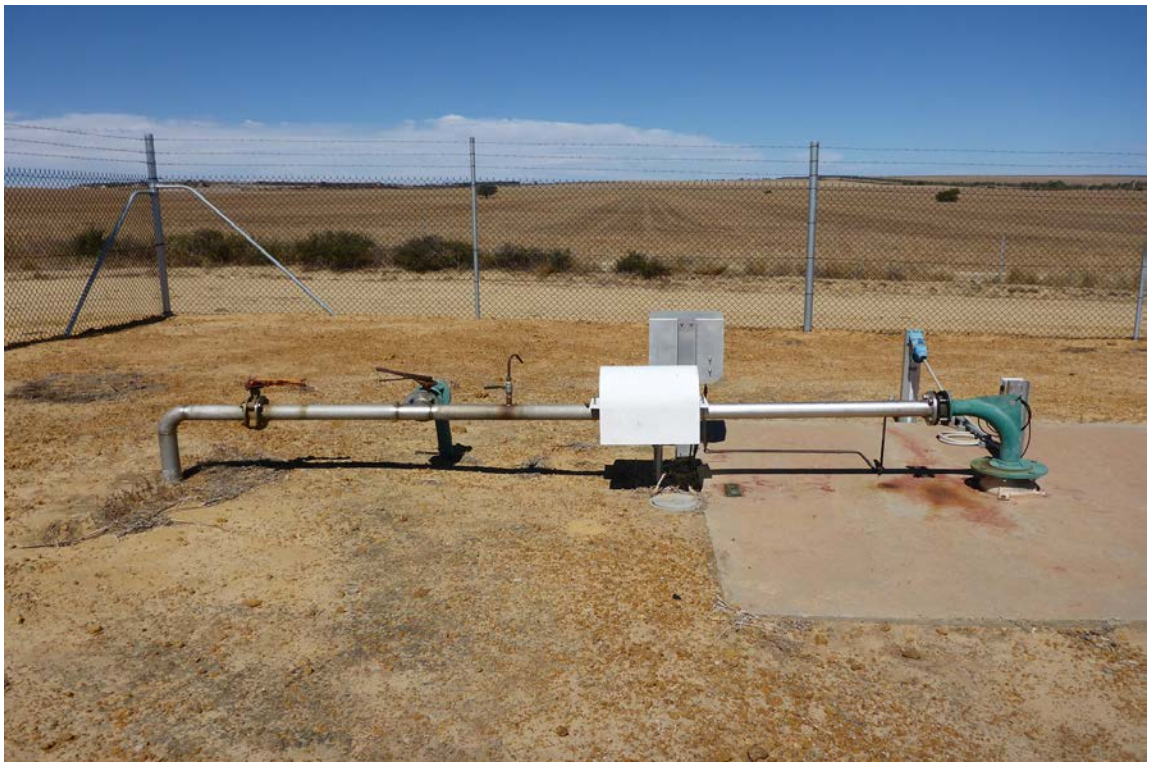

Figure C4 Fenced bore (3/87) compound with broadacre farmland in background, photograph by M. Sawyer, Water Corporation

Figure C5 *New bore 1/13, yet to be fenced, photograph by M. Sawyer, Water Corporation*

Figure C6 *Bore 5/86 in signed fenced compound; sealed road and farmland in background, photograph by M. Sawyer, Water Corporation*

Figure C7 *Mingenew water treatment plant in a fenced, signed compound, photograph by M. Sawyer, Water Corporation*

Figure C8 *Mingenew racetrack and sports oval (seasonally irrigated) in the north of the Mingenew Water Reserve, photograph by Shire of Mingenew*

Figure C9 *The Autumn Centre (community building for senior citizens) in the north of the Mingenew Water Reserve, photograph by Shire of Mingenew*

Appendix D — Typical contamination risks in groundwater sources

Land development and land- or water-based activities within a water reserve can directly affect the quality of drinking water and its treatment. Contaminants can reach drinking water sources through runoff over the ground and infiltration through soil. A wide range of microbiological, chemical and physical contamination risks can impact on water quality and therefore affect the provision of a reliable, safe, good quality drinking water to consumers.

Some contaminants in drinking water can affect human health, resulting in illness, hospitalisation or even death. Other impurities can affect the water's aesthetic qualities, including its appearance, taste, smell and 'feel' but are not necessarily hazardous to human health. For example, cloudy water with a distinctive odour or strong taste may not be harmful to health, but clear, pleasant-tasting water may contain harmful microorganisms that are undetectable by sight, taste or smell. (NHMRC & NRMMC 2011). Contaminants can also interfere with water treatment processes, and damage water supply infrastructure (such as iron corroding pipes).

The *Australian drinking water guidelines* (ADWG; NHMRC & NRMMC 2011) outline criteria for acceptable drinking water quality to protect human health, manage aesthetics and maintain water supply infrastructure.

Some commonly seen contamination risks relevant to groundwater drinking water sources are described below.

Microbiological risks

Pathogens are types of microorganisms that are capable of causing illness and include bacteria, protozoa and viruses. When people consume drinking water that is contaminated with pathogens, the consequences vary considerably, ranging from mild illness (such as stomach upset or diarrhoea) to hospitalisation and in some cases even death. For example, seven people died and about 2500 became ill in Walkerton, Canada, during 2000, because the town's water supply was contaminated by a pathogenic strain of *E. coli* and *Campylobacter* (NHMRC & NRMMC 2011).

The types of pathogens that are likely to cause harm to people are commonly found in the faeces of humans and domestic animals (such as dogs and cattle). These pathogens can enter drinking water supplies from faecal contamination in the catchment area, either directly or indirectly.

In groundwater sources, this occurs indirectly. Faecal material can infiltrate through the soil and into the groundwater. For example, contamination can occur from septic tanks or grazing animals.

A number of pathogens are commonly known to contaminate water supplies worldwide. These include bacteria (for example *Salmonella*, *Escherichia coli* and cholera), protozoa (such as *Cryptosporidium* and *Giardia*) and viruses. Monitoring for

the presence of *E. coli* in water supplies provides an indication of the level of recent faecal contamination.

Pathogen contamination of a drinking water source is influenced by many factors including the existence of pathogen carriers (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 survival and movement of pathogens in groundwater is influenced by the characteristics of the pathogen (such as its size and inactivation rate) and the groundwater properties (including flow rate, porosity, amount of carbon in the soil, temperature and pH). Inactivation rate (the time it normally takes a pathogen to decay) is one of the most important factors governing how far pathogens may migrate. Typical half-lives of pathogens range from a few hours to a few weeks. For example, some reported migration distances of bacteria in groundwater are:

- 600 m in a sandy aquifer
- 1000–1600 m in channelled limestone
- 250–408 m in glacial silt-sand aquifers (Robertson & Edbery 1997).

Unlike chemicals, which dissipate and dilute when they enter a water source, pathogens can multiply under the right conditions, increasing the likelihood of contamination. Therefore it is important to understand both the surface water and groundwater systems to be able to protect the drinking water source from pathogens.

Given the wide variety of pathogens, their behaviour in the environment and the potential consequences of consuming contaminated water, the most effective way to protect public health and reduce water treatment costs is to avoid the introduction of pathogens into a water source.

Physical risks

Turbidity is the result of soil or organic particles becoming suspended in water. Increased turbidity can result in cloudy or muddy-looking water, which is not aesthetically appealing to consumers. Turbidity can also reduce the effectiveness of treatment processes (such as disinfection). This is because pathogens and chemicals can attach onto soil particles, make them more difficult to remove during disinfection and treatment processes.

Other physical properties of water can affect water supply infrastructure, or the aesthetics of the drinking water. For example, pH can contribute to the corrosion and encrustation of pipes; iron and dissolved organic matter can affect the colour and smell of water; and salinity levels can affect its taste. Although not necessarily harmful to human health, water with properties like this will be less appealing to customers.

Chemical risks

Chemicals can occur in drinking water as a result of natural leaching from mineral deposits or from different land uses (NHMRC & NRMMC 2011). A number of these chemicals (organic and inorganic) are potentially toxic to humans.

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

Hydrocarbons such as fuels and oils are potentially toxic to humans. Harmful chemical by-products may be formed when hydrocarbons are combined with chlorine during the water treatment process. Hydrocarbons can occur in water supplies as a result of spills and leaks from vehicles and machinery.

Drinking water sources can also be contaminated by nutrients such as nitrogen and phosphorus. Nutrients can be introduced into a catchment via the application of fertiliser, from septic systems, and from animal faecal matter that washes through soil and into the groundwater. Nitrate and nitrite are two forms of nitrogen that can be toxic to humans at high levels, with infants younger than three months being most susceptible (NHMRC & NRMMC 2011).

Other chemicals and heavy metals can be associated with land uses such as industry and landfill. These may enter groundwater and could be harmful to human health if consumed.

Appendix E — How do we protect public drinking water source areas?

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

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

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

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

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

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

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

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

cooperatively with other agencies and the community to implement this legislation and develop drinking water source protection reports. For example, the Western Australian Planning Commission has developed a number of state planning policies to help guide development in public drinking water source areas.

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

The department's Water quality protection note (WQPN) no. 25: *Land use compatibility tables for PDWSAs* outlines appropriate development and activities within each of the priority areas (P1, P2 and P3).

With 129 proclaimed PDWSAs across Western Australia, the department prioritises the update of drinking water source protection reports (such as this document). Our aim is to update each report every seven years. In some locations, more frequent updates may be required to address changing water quality risks and land uses. These updates allow us to make changes to the PDWSA boundary, priority areas and protection zones if required. They also allow solutions to new water quality risks to be considered.

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

There is a fourth type of report – Land use and water management strategy – that performs the same functions as a drinking water source protection report. However, these strategies are prepared by the Western Australian Planning Commission (with input from the Department of Water and Environmental Regulation) and are strategic documents that integrate land use planning with water management. There are currently land use and water management strategies for Gnangara, Jandakot and Middle Helena.

If you would like more information about the ADWG and how we protect drinking water in Western Australia, visit www.water.wa.gov.au > urban water > drinking water or refer to our WQPN no. 36: *Protecting public drinking water source areas*. You can also contact the department's Water source protection planning branch on +61 8 6364 7600 or email drinkingwater@dwer.wa.gov.au.

Drinking water source protection reports produced by the department

Drinking water source protection report	Scope and outcome	Consultation	Time to prepare	Implementation table	Proclamation
Drinking water source protection assessment (DWSPA)	Desktop assessment of readily available information.	Preliminary	Up to 3 months	No	Proclamation to protect water quality and guide land use planning can occur as a result of any type of drinking water source protection report.
Drinking water source protection plan (DWSPP)	Full investigation of risks to water quality building on information in the DWSPA.	Public	6–12 months	Prepared from recommendations in the DWSPA and/or information from public consultation.	
Drinking water source protection review (DWSPR)	Review changes in land and water factors and implementation of previous recommendations. Sometimes prepared to consider specific issues in a PDWSA.	Key stakeholders	3–6 months	Prepared from recommendations in the DWSPA or DWSPP.	

Appendix F — Understanding risks to drinking water quality

The existing integrated land use planning and public drinking water source area (PDWSA) protection program is based on the findings of three parliamentary committee reports in 1994, 2000 and 2010 (see *Further reading*). Since 1995, this integrated program has resulted in the development of four Western Australian Planning Commission state planning policies (SPPs), recognising the importance of PDWSAs for the protection of water quality and public health:

- SPP no. 2.2: *Gnangara groundwater protection*
- SPP no. 2.3: *Jandakot groundwater protection*
- SPP no. 2.7: *Public drinking water source policy*
- SPP no. 2.9: *Water resources*.

This integrated program relies upon an assessment process based on preventive risk in each PDWSA through the development of drinking water source protection reports. It is important to understand how risks are assessed to appreciate the impact of development within PDWSAs.

Risk-based assessments normally focus on the acceptability of risks after mitigation (residual risks). For drinking water sources, an assessment based on preventive risk, that considers both the maximum and residual risks is required. This means that in some cases, the maximum risks from land uses will still be considered unacceptable, even after mitigation has reduced the risk. This is a more conservative approach needed to protect the health of consumers.

Water quality risks are evaluated by considering the type and scale of a potential contamination event (consequence), together with the probability/frequency of that event occurring (likelihood). An understanding of this relationship will prevent the common misunderstanding that probability equals risk (see risk matrix below).

Risk matrix: Level of risk (from the Australian drinking water guidelines *2011)*

Likelihood	**Consequences**				
	Insignificant	**Minor**	**Moderate**	**Major**	**Catastrophic**
Almost certain	Moderate	High	Very high	Very high	Very high
Likely	Moderate	High	High	Very high	Very high
Possible	Low	Moderate	High	Very high	Very high
Unlikely	Low	Low	Moderate	High	Very high
Rare	Low	Low	Moderate	High	High

For example, just because a drinking water contamination incident has not occurred for many years (low likelihood) does not mean that the risk is low, because we also need to consider the consequence of that contamination when determining risk. Furthermore, no previous detection of contamination is not proof that the risk is acceptable.

Shortened forms

List of shortened forms

ADWG	*Australian drinking water guidelines*
ANZECC	Australian and New Zealand Environment Conservation Council
HAZMAT	hazardous materials
MPN	most probable number
NHMRC	National Health and Medical Research Council
NRMMC	Natural Resource Management Ministerial Council
NTU	nephelometric turbidity units
P1, P2, P3	priority 1, priority 2, priority 3
PDWSA	public drinking water source area
RPZ	reservoir protection zone
WAPC	Western Australian Planning Commission
WHPZ	wellhead protection zone
WQPN	water quality protection note

Units of measurement

Bq/L	becquerel per litre
mSv	millisievert
mg/L	milligram per litre

Volumes of water

One millilitre	0.001 litre	1 millilitre	(mL)
One litre	1 litre	1 litre	(L)
One thousand litres	1000 litres	1 kilolitre	(kL)
One million litres	1 000 000 litres	1 megalitre	(ML)
One thousand million litres	1 000 000 000 litres	1 gigalitre	(GL)

Glossary

Abstraction	The pumping of groundwater from an aquifer, or the removal of water from a waterway or water body.
Aesthetic guideline value	The concentration or measure of a water quality characteristic that is associated with acceptability of water to the consumer, for example appearance, taste and odour (NHMRC & NRMMC 2011).
Allocation	The volume of water that a licensee is permitted to abstract, usually specified in kilolitres per annum (kL/a).
Aquifer	A geological formation or group or formations able to receive, store and transmit significant quantities of water.
Australian drinking water guidelines	The *National water quality management strategy: Australian drinking water guidelines 6*, 2011 (NHMRC & NRMMC 2011) (ADWG) outlines acceptable criteria for the quality of drinking water in Australia (see *References*).
Becquerel	A measure of radioactivity, as per the International System of Units.
Bore	A narrow, lined hole drilled into the ground to monitor or draw groundwater (also called a well).
Bore field	A group of bores to monitor or withdraw groundwater (also see *wellfield*).
Casing	A large diameter pipe that is assembled and inserted into a recently drilled section of a borehole and typically held into place with cement.
Contamination	A substance present at concentrations exceeding background levels that presents – or has the potential to present – a risk of harm to human health, the environment, water resources or any environmental value.
Drinking water source protection report	A report on water quality hazards and risk levels within a public drinking water source area; includes recommendations to avoid, minimise, or manage those risks for the protection of the water supply in the provision of safe drinking water supply.
Health guideline value	The concentration or measure of a water quality characteristic that, based on current knowledge, does not result in any significant risk to the health of the consumer over a lifetime of consumption (NHMRC & NRMMC 2011).

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 branch of geology that deals with the occurrence, distribution and effects of groundwater. It is the study of groundwater, especially relating to the distribution of aquifers, groundwater flow and groundwater quality.
Leaching/ leachate	The process by which materials such as organic matter and mineral salts are washed out of a layer of soil or dumped material by being dissolved or suspended in percolating rainwater. The material washed out is known as leachate. Leachate can pollute groundwater and waterways.
Metres below top of casing	Bore depth expressed in metres below the top of the bore casing.
mg/L	A measurement of something (such as salinity) in a solution, i.e. 0.001 grams per litre.
Microbe	A microorganism, usually one of vegetable nature, a germ. Also known as a bacterium, especially one causing illness.
Most probable number	A measure of microbiological contamination.
Nephelometric turbidity units	A measure of turbidity in water.
Nutrients	Minerals, particularly inorganic compounds of nitrogen (nitrate and ammonia) and phosphorous (phosphate) dissolved in water which provide nutrition (food) for plant growth.
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.
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.

Pollution	Water pollution occurs when waste products change the physical, chemical or biological properties of the water, adversely affecting water quality, the ecosystem and beneficial uses of the water.
Porosity	The ratio of water (or air) filled pore spaces to the total volume of the rock or soil, expressed as a percentage or fraction.
Public drinking water source area	The area from which water is captured to supply drinking water. It includes all underground water pollution control areas, catchment areas and water reserves constituted under the *Metropolitan Water Supply, Sewerage, and Drainage Act 1909* or the *Country Areas Water Supply Act 1947*.
Priority 1, 2 and 3	Three different priority areas are assigned within PDWSAs to guide land use decisions. The objective of priority 1 (P1) areas is *risk avoidance*, priority 1 (P2) areas is *risk minimisation* and priority 3 (P3) areas is *risk management*.
Public sector circular number 88	A state government circular produced by the Department of Health providing guidance on appropriate herbicide use within water catchment areas.
Recharge	The action of water infiltrating through the soil/ground to replenish an aquifer.
Recharge area	An area through which water from a groundwater catchment percolates to replenish (recharge) an aquifer. An unconfined aquifer is recharged by rainfall throughout its distribution. Confined aquifers are recharged in specific areas where water leaks from overlying aquifers, or where the aquifer rises to meet the surface.
Runoff	Water that flows over the surface from a catchment area, including streams.
Scheme supply	Water diverted from a source or sources by a water authority or private company and supplied via a distribution network to customers for urban and industrial use or for irrigation.
Semi-confined aquifer	A leaky aquifer, saturated and bounded above by a semi-permeable layer and below by a layer that is either impermeable or semi-permeable.
Stormwater	Rainwater that has runoff the ground surface, roads, paved areas etc., and is usually carried away by drains.
Superficial aquifer	Shallow (near to the surface) aquifers which are easily recharged and can be readily accessed by bores.

Total dissolved solids	Consists 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 2011).
Total filterable solids by summation	A water quality test which is a total of the following ions: Na (sodium), K (potassium), Ca (calcium), Mg (magnesium), Cl equivalent (chloride), alkalinity equivalent, SO_4 equivalent (sulfate) or S (sulfur) in grams, Fe (iron), Mn (manganese), and SiO_2 (silicon oxide). It is used as a more accurate measure than total dissolved solids. The higher the value, the more solids that are present and generally the saltier the taste.
Treatment	Application of techniques such as settlement, filtration and chlorination to render water suitable for specific purposes, including drinking and discharge to the environment.
Turbidity	The cloudiness or haziness of water caused by the presence of fine suspended matter.
Unconfined aquifer	An aquifer where the upper boundary is the watertable and therefore is in contact with the atmosphere through the pore spaces in the unsaturated zone. Typically (but not always) it is the shallowest aquifer at a given location.
Wastewater	Water that has been used for some purpose and would normally be treated and discarded. Wastewater usually contains significant quantities of pollutant.
Water quality	Collective term for the physical, aesthetic, 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.
Wellfield	A group of bores located in the same area used to monitor or withdraw groundwater.
Wellhead	The top of a well (or bore) used to draw groundwater.

Wellhead protection zone	Usually declared around wellheads in public drinking water source areas to protect the groundwater from immediate contamination risks.
Westplan–HAZMAT	State emergency management plan for hazardous materials emergencies.

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