Safe Drinking Water Act 2011

Standard Drinking Water Risk Management Plan

GUIDANCE MANUAL (used to complete RMP Template)

Bore water supplies with reverse osmosis treatment and disinfection

Government of South Australia
SA Health

Background

The *Safe Drinking Water Act 2011* (the Act) and Safe Drinking Water Regulations 2012 (the Regulations) apply to all drinking water providers who supply water to the public. Under the Act drinking water providers must prepare and implement a drinking water risk management plan (RMP).

What is a drinking water risk management plan?

A risk management approach is recommended in the Australian Drinking Water Guidelines (ADWG) and the World Health Organisation's Guidelines for Drinking-water Quality. A drinking water RMP is a document that identifies hazards and associated risks that may affect drinking water quality. A RMP also documents preventative measures that have been identified to reduce or eliminate these risks and the day-to-day operational requirements for managing the system.

The level of detail contained in a RMP will vary according to the size, complexity and risk associated with the drinking water supply system. RMPs for small bore water based drinking water supplies do not require as much detail as those generated for complex drinking water supplies.

About this document

This guidance manual is to be used in conjunction with the *Template – Standard RMP document for bore water supplies with RO and disinfection* (**template document**). It contains all relevant information and step-by-step instructions for drinking water providers to prepare a Standard RMP. Adoption of an appropriate standard RMP fulfils the requirements of Part 3 of the Act in regard to RMPs.

Some sections of the RMP are standard for all bore water drinking water supplies, and where applicable criteria have been pre-populated into the template document. Completion of the RMP requires the input of system specific information into the *Template – Standard RMP document for bore water supplies with RO and disinfection* **(template document)** using the following 9 steps (page number reference provided for relevant item in the **template document**):

Step 1: Provide RMP document control and review details (page 3)

Step 2: List relevant key contacts (page 3)

Step 3: Provide system description and schematic of your drinking water supply (page 4)

Step 4: Undertake risk assessment of water quality hazards (page 7)

Step 5: Review and modify the maintenance program (page 10)

Step 6: Review water quality testing program – populate tables 4.1 – 4.3 (page 13)

Step 7: Review and modify incident response criteria – (page 14)

Step 8: Identify personnel responsible for activities associated with RMP (page 16)

Step 9: Prepare record keeping documents using documentation templates in Appendix B

Who can adopt a standard RMP for small bore water supplies?

This RMP is for drinking water providers who supply water for a bore supply with reverse osmosis treatment and disinfection (but not limited to):

- Mining camps and accommodation
- Small townships with multiple dwellings

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For drinking water quality assistance and enquires contact

Water Quality Unit, SA Health

- Phone: 0421 618 311 – for incident reporting
- Phone 8226 7100 – for non-incident related enquires
- Email: waterquality@sa.gov.au

Document control and review

Document control ensures that the latest version of the RMP is being used and implemented. The RMP should be reviewed on an annual basis or more frequently if required. Documentation related to, or generated, as part of the plan (such as inspection reports, incident reports, water quality test results) must be kept for at least 5 years.

Step 1: *Provide RMP document control and review details in the* ***template document.***

RMP prepared by	Who prepared the Standard RMP document?
Date prepared	Date the Standard RMP was finalised / approved by SA Health
Version number	Version number of the Standard RMP document.
Next revision date	At least 12-month review frequency

Key contacts

The Act requires registration of a drinking water provider prior to the supply of water. The registered drinking water provider is the person responsible for the operation of the drinking water system and the supply of drinking water to customers. Once the *Template – Standard RMP for bore supplies with RO and disinfection* (**template document**) has been completed and approved by SA Health, a letter addressed to the drinking water provider will be issued outlining any conditions of registration. **SA Health must be notified of any changes to the business details within 14 days of the change being made.**

Step 2: *List relevant business details of the drinking water provider in the* ***template document****. These details are used to complete the registration process.*

Business details

Business trading name	The business / trading name of the registered drinking water provider – include on front cover of template document
Name of Owner / manager (registered drinking water provider)	The owner / manager (registered drinking water provider) who is responsible for meeting all requirements of the *Safe Drinking Water Act 2011* as outlined in the approval.
Contact details of the registered drinking water provider / water supply	Phone number, email address, website, location of business / drinking water supply
Address	Postal address for the registered drinking water provider (if different from above)
Operator name and contact details	The operator who undertakes the day-to-day management of the drinking water supply

Other important contacts

Name	**Name and Phone Number**
Local Council	The local council area where the business is located
Water Testing Laboratory	The SA Health approved water testing laboratory used to undertake water quality testing (see Section 4)
Water Treatment Company	Contact details of water treatment company
Tank Cleaning Company	Contact details of tank cleaning company
Water Carting Company	Contact details of SA Health registered water carting company

Section 1: Description of drinking water supply system

It is essential that a drinking water provider has a good understanding of their water supply system. Here are the key components to include when preparing a system description of your water supply.

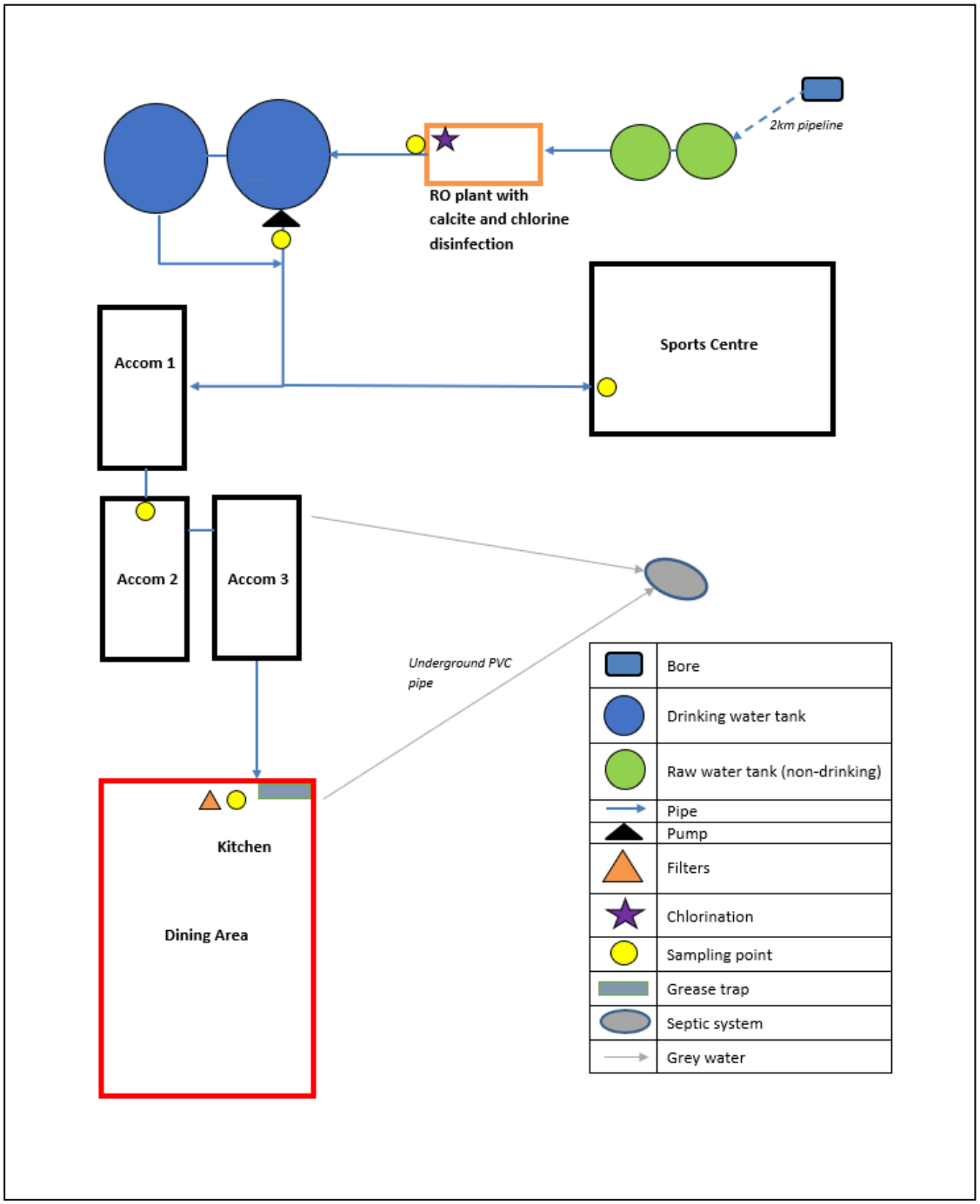
Step 3: *Prepare a system description and schematic / diagram of your drinking water supply in Table 1 in the **template document** using the key components / questions outlined below. Photographs of the water supply infrastructure are useful. Additional pages can be inserted if required.*

Table1: Key components of the drinking water supply

Use of drinking water supply	▪ Summarise how the drinking water is being used. (e.g., used for mining accommodation including catering facilities for approximately 200 people). ▪ Is the drinking water used continuously or sporadically?
Surrounding catchment environment	▪ What is the land activity in the surrounding catchment environment? (e.g., horticultural, farming, domestic) ▪ Are there any sheds with chemicals nearby? Is so, what chemicals and how much? What is the distance to the chemical store? Does the shed have a concrete pad? ▪ Are there any animals grazing nearby? If so, what animals and how far are the animals kept from the bores? ▪ Is there a septic tank in the vicinity of the bores?
Bore details Your bore drilling report or WaterConnect can assist with providing some of the information	▪ What is the Water Connect Unit number for the bore? ▪ When was the bore drilled? What is the bore depth? ▪ Is the bore in a confined or unconfined aquifer? ▪ What is the bore casing constructed from? (e.g., PVC, cast iron) ▪ Is there a concrete plinth around the base of the bore? ▪ Can water enter the bore or pool near the bore head? ▪ What is the quality of the raw bore water for parameters such as pH, total dissolved solid, iron etc? What regular raw water monitoring is conducted prior to the RO treatment?
Raw water tank(s)	▪ What is the size and construction of the tank? ▪ What condition / integrity of the raw water tank – good or poor?
Reverse Osmosis Treatment (including pre-filters if present)	▪ Provide details of reverse osmosis treatment with any pre-sediment filtration including make and model of the equipment. Equipment specification guides for these products are useful. The water treatment company that installed the unit may also provide this information. ▪ What is the target conductivity on the outlet of the RO plant? What online monitoring is in place to measure conductivity? What are the alarm set-points (Hi, Lo) on the fault alarm for the RO treatment? Will the plant shut-down on a high conductivity reading? ▪ What is the cleaning method for the RO plant and how often is this undertaken? ▪ Who monitors the online instrumentation and responds to an outage at the treatment plant.

pH dosing	▪ Is pH dosing used for conditioning the treated water following RO? If so, what chemical is used? i.e. calcite, lime (calcium oxide) or caustic soda (sodium hydroxide). ▪ What is the pH dosing chemical rate? What is the target pH to be measured? Include details of the online and handheld instrumentation is in use. What are the alarm set points (Hi, Lo) on the fault alarm for the pH dosing equipment / analyser?
Disinfection Refer to relevant sections	▪ Provide details of the method and equipment specifications used for disinfection. ▪ **For UV disinfection**: What is the Ultraviolet (UV) disinfection dose rate? This can be found in the specification guide. It is dependent on the flow of water in the unit. How is operation of the UV disinfection unit monitored e.g. (indicator light/alarm with SMS notification or daily checks). Does the water flow stop when the UV disinfection is not working? ▪ **For chlorine disinfection**: What is the chlorine dose rate? What is the target chlorine residual to be measured on the chlorine analyser? Include details of the handheld instrument used to check the chlorine analyser and downstream chlorine residuals. What are the alarm set-points (Hi, Lo) on the fault alarm on the dosing equipment / analyser?
Treated water tank(s)	▪ Are there any treated water tanks in the system following ? ▪ What is the construction and size of the tank? ▪ What is the condition of the treated water tank? ▪ Does the tank have a separate inlet / outlet or common inlet / outlet and can the water short-circuit causing water quality issues ▪ How often does the treated water tank turn-over? ▪ Where is the sample tap for the tank?
Distribution Network	▪ Where is this water delivered? e.g., to arrange of sleeping accommodation including bathrooms and kitchenettes, office with kitchen and a large dining hall with full catering facilities ▪ Where is the last location in the network? Will water become stagnant at the end of the system and require regular flushing? ▪ Approximate length of pipework and type (e.g., copper, PVC) ▪ Is pipework above or underground?
Water quality sampling locations and analysis	▪ The size of the distribution network determines the number of samples that are taken. For a medium size network (approximately 2 km of network) 3 to 4 samples would be required. ○ After disinfection ○ Treated water tank ○ Within the network / at the point of use (i.e. kitchen tap) ○ Near the end of the system ▪ Where are the water quality samples taken? ▪ How many samples are collected from the supply? ▪ Which laboratory is used to analyse the samples and how are results received? ▪ **For supplies with chlorine disinfection:** what are the target chlorine residuals in the network (at least 2 locations) including at the end of the network (ideally approximately 0.2 mg/L free chlorine). Who undertakes the weekly testing and where is it recorded?

An example of a schematic of a bore water supply with reverse osmosis and chlorine disinfection (include a separate RO plant system diagram):



Section 2: Water Quality Hazards

Drinking water providers should be aware of the potential hazards that represent risk to bore water quality and implement appropriate preventive measures. Many of the hazardous events outlined below can be avoided through the completion of regular maintenance as documented in Section 3.

Step 4: *Undertake a risk assessment of your drinking water supply. Populate Table 2 in the* ***template document*** *with identified hazards for your drinking water supply. Below is a comprehensive list of potential hazards, select hazards that are relevant to your drinking water supply, noting that some hazards may develop over time if the system is not properly maintained.*

Table 2: Hazards, risks, and preventive measures

Hazardous event	Risk	Preventive Measure
Shallow unprotected bore – unconfined aquifer, depth less than 20 m	▪ Increased risk of bore contamination from pathogens or chemicals	▪ Where possible bores should be drilled into a confined aquifer and at the greatest depth to prevent contaminants entering the supply. ▪ Increase monitoring and maintenance requirements for Reverse Osmosis and disinfection ▪ Increase water quality testing of microbiological and chemical parameters (see Section 3)
Livestock entry to bore protection zone	▪ Increased risk of bore contamination from livestock waste	▪ Bore should be protected from livestock access (e.g.by fencing in agricultural areas) to allow at least a 50 metre radius around the bore
Leakage from sewage collection system	▪ Increased risk of bore contamination from human waste	▪ Bore should be protected from human waste by not allowing discharge from an on-site wastewater system within 50 metres of the bore (per the On-site Wastewater Systems Code) ▪ On-site wastewater systems should not be installed within 10 metres of a bore (per the On-site Wastewater Systems Code)
Toxic chemicals leaching into groundwater	▪ Health or aesthetic impact of chemicals	▪ Agricultural chemicals, diesel and petrol should not be stored or used within the minimum protection zone except in areas with physical barriers to prevent spills contaminating ground water
Backflow from household plumbing devices or water storages can contaminate drinking water systems including mains water where connected	▪ Illness from ingestion of harmful pathogens. ▪ Health or aesthetic impact of chemicals	▪ Backflow prevention devices should be installed in accordance with the plumbing code (AS/NZS 3500)

Hazardous event	Risk	Preventive Measure
Entry of birds and small animals into treated water tank	▪ Illness from ingestion of harmful pathogens contained in faecal material or from dead animals	▪ All tank openings should be sealed or covered with mosquito-proof mesh. ▪ Tank/tank roof integrity should be maintained to prevent access points.
Mosquitoes breeding in raw and treated water tank(s)	▪ Nuisance and potential transmission of arbovirus (e.g. Ross River virus	
Algal growth in pipework and / or raw water tank	▪ Aesthetic ▪ Taste and odour issues: Musty, vegetable, or fishy type taste and odours	▪ Light access into storage tanks should be prevented (e.g., ensure tank is completely roofed) ▪ Ensure pipework is impervious to light (white or opaque pipes can allow light penetration)
Power Failure	▪ Health or aesthetic impacts from untreated water entering the supply	▪ Back-up power supply is available to the water treatment plant to prevent interruptions to water treatment processes ▪ Plant shut out on loss of power
Reverse Osmosis plant Failure of RO plant leading to contaminants in the raw water entering the supply	▪ Health or aesthetic impacts from untreated water entering the supply	▪ Undertake maintenance schedule of the RO plant as per manufacturer's specification ▪ Ensure that the feed water meets requirements for membrane filters following pre-treatment with coarse filtration ▪ Monitor membrane performance on a daily basis ▪ Ensure alarm and automatic shutoff has been installed to indicate membrane failure or need for maintenance
pH dosing Failure of pH dosing leading to an impact on the product water	▪ Aesthetic ▪ pH <6.5 may corrode pipe and fittings; pH > 8.5 may cause scale and taste problems	▪ Continuous monitoring of pH dosing is undertaken ▪ Ensure fault alarm is operational ▪ Ensure dosing equipment and pH analyser are checked on a weekly basis and calibrated as per manufacturers specification ▪ Routine procedures are in place for maintaining adequate chemical supply stocks
Chlorine disinfection- Too much chlorine added to water during chlorination	▪ Irritation of skin and mucous membranes ▪ Customer complaints due to taste and odour	▪ Ensure dosing equipment and chlorine analyser are checked on a weekly basis and calibrated as per manufacturers specification. ▪ Measure the chlorine residual in the network on a weekly basis and ensure target residuals from chosen locations are within specification.

Hazardous event	Risk	Preventive Measure
Chlorine disinfection – Failure of disinfection system or underdosing leading to no chlorine in the distribution system	▪ Reduced protection from microbial contamination	▪ Ensure fault alarm system is operational.
Chlorine disinfection - Insufficient chlorine supplies	▪ Reduced protection from microbial contamination	▪ Routine procedures are in place for maintaining fresh stock and on-site storage of sufficient supply ▪ Automatic shut-down of supply if chlorination fails ▪ Alarms installed on chemical supply tanks and cylinder scales

Treatment options for bore water

Installation of treatment processes can be considered for protecting the microbiological quality of bore water at all times. The most common type of treatment include filtration, UV disinfection and chlorination.

Filtration

Water sourced from a well-maintained deep bores should not require filtration to improve microbiological quality. More commonly filtration is used to remove sediment or suspended particles from water to improve performance of disinfection (see below). Depending on the type of filter, contaminants such as bacteria and viruses can also be removed. Point of use filters (e.g., under-sink carbon or ceramic filtration units) are commonly installed to improve the taste and odour of water.

Where filters are in use, they must be operated, maintained, and replaced as per the manufacturer's recommendations to avoid problems associated with microbial growth. Filters that are not maintained correctly may not work effectively and may have adverse impacts on water quality.

Minimum requirements for the use of a filtration system includes:

- Maintenance program in line with manufacturers specification for cleaning and replacement of filters

Reverse Osmosis

Reverse Osmosis (RO) is used to filter brackish bore water or seawater to reduce salt levels. RO works using high-pressure pump to apply pressure on the salt side of the RO system and to force the water across the semi-permeable RO membrane, leaving almost all (95-99%) of total dissolved salts behind in the reject stream. Generally RO is used as the final part of a staged filtration process.

Trans-membrane pressure (TMP) is calculated by determining the difference between the average feed pressure and the permeate pressure of the membrane. This pressure is measured in bar or psi and is the driving force for membrane separation and permeate production.

Minimum requirements for the use Reverse Osmosis include:

- The Australian Drinking Water guideline aesthetic limit for total dissolved solids is 600 mg/L (equivalent to conductivity 1000 $\mu S.cm^{-1}$)
- Use trans-membrane pressure (as per manufacturer's specification) to measure reserve osmosis treatment efficiency and effectiveness. Exceedance of TMP identifies cleaning and / repair requirements for the RO membranes.
- Use reliable monitoring equipment including an online conductivity meter to measure the conductivity of the treated water with a fault alarm. A reverse osmosis failure is a notifiable incident to SA Health (see Section 5).
- Maintenance program in line with manufacturers specification for cleaning and replacement of filters

Ultraviolet (UV) light disinfection

UV disinfection can be used to provide continuous assurance of water quality at point of application. UV disinfection systems require relatively low maintenance and have the advantage of not involving the addition of chemicals. UV disinfection systems can be installed in pipework delivering water from a tank to a dwelling, or selectively to taps used to supply water for drinking and food preparation.

Standard UV disinfection systems deliver a dose of 40 mJ/cm^2. Maintaining this dose is important to ensure the effective control of micro-organisms. The UV dose applied to water is determined by the flow rate of water through the UV unit. Details of the flow rate will be specified by the manufacturer and need to be followed. UV disinfection is only effective in treating water with a low turbidity therefore maintenance activities to prevent increases in turbidity (e.g. from ingress of surface water or soils) are critical. Installation of sediment and particle filters before disinfection is common practice. The need for filtration will generally be based on manufacturer specifications.

As there is no disinfection residual to measure following UV light disinfection, the system should be closely monitored to ensure that it is operating as expected at all times. A fault alarm should be installed on the unit with immediate notification to the drinking water provider preferably with an audible or remotely monitored alarm. If this is not available then the UV disinfection must be checked on a daily basis. Most UV lamps will need to have their sleeves cleaned regularly to reduce biofilm or scale. In addition, the lamps will need to be replaced between nine and twelve months. If power to the UV disinfection unit is interrupted the system should be designed to stop water flow into the drinking water system until disinfection is restored.

Minimum requirements for the use of UV disinfection include:

- UV disinfection dose of 40 mJ/cm^2 (a UV disinfection dose >30 mJ/cm^2 may be considered acceptable depending on source water quality, discuss with Water Quality Unit, SA Health)
- Clean UV disinfection lamp sleeves regularly and replace lamps as per manufacturers instruction
- A fault alarm with direct notification to drinking water provider, if not available daily checking that UV disinfection is operational with log sheet to record as evidence. A UV disinfection failure is a notifiable incident to SA Health (see Section 5)

Chlorine disinfection

Chlorine is the most commonly used drinking water disinfectant. It is a strong disinfectant and is effective at short contact time against viruses and bacteria (e.g. *E.coli*). The Australian Drinking Water Guidelines value for chlorine is 5 mg/L

Unlike UV disinfection a chlorine residual can persist in the water distribution network and will prevent growth of biofilm and provide protection against ingress of microbiological contamination through minor faults in pipework or storages.

Liquid sodium hypochlorite is generally the source of chlorine used in smaller drinking water supplies. Strict safety requirements are associated with the use of liquid chlorine. Disadvantages of sodium hypochlorite are that the concentrations degrade over time, chlorate can be formed during storage, and it is a corrosive solution. Solid calcium hypochlorite is also available and can be applied in a powder or tablet form and is generally used for emergency chlorination. Calcium hypochlorite needs to be stored in a cool dry environment and kept away from moisture and heat. Stabilised calcium hypochlorite tablets or chlorine containing cyanuric acid are not suitable for use in drinking water.

Chlorinators are typically installed prior to any tanks in the system (which are a common source of contamination). Reliable dosing and monitoring equipment is available and can be set up by a water treatment company. The chlorine dose can be set to achieve both initial disinfection and to provide chlorine residuals reaching the end of the distribution system. The dosing equipment should be monitored online and alarmed to notify the drinking water provider of an overdosing (greater than 5 mg/L) or underdosing event so that remedial action can be put in place. Regular maintenance of the dosing equipment and monitoring is required. If power to the chlorination unit is interrupted the system should be designed to stop flow of undisinfected water into the system .

Reliable field kits for measuring chlorine residuals in the distribution system are available. Regular weekly free chlorine measurements at different points in the distribution network are important to closely monitor the presence of chlorine residuals. Seasonal variations and water age can have an impact on the residual measured in the network and may require adjustment of chlorine doses at different times of the year. The aim should be to provide a free chlorine residual of 0.2 mg/L at the last point in the distribution network.

Minimum requirements for the use of chlorine include:

- The Australian Drinking Water Guideline value for chlorine is 5 mg/L (maximum)
- Use reliable dosing and monitoring equipment including an online chlorine analyser to measure the chlorine dose. Ensure this equipment has a fault alarm with direct notification to the drinking provider. A chlorination failure is a notifiable incident to SA Health (see Section 5)
- Record the free chlorine residual in the network on a weekly basis. Set the chlorine dose, and target chlorine residuals to achieve at least 0.2 mg/L free chlorine at the end of the distribution network.

Further information regarding installation and cost of UV and chlorination disinfection systems can be obtained through contacting a water treatment company (look in the Yellow Pages® under ‘Water Treatment & Equipment’).

Additional information on treatment options such as boiling, and emergency chlorination are provided in Appendix A.

Section 3: Maintenance program

Regular maintenance can prevent hazardous events in your water supply that can lead to a water quality incident. Records of completed maintenance activities must be kept with the RMP.

Step 5: *The approved maintenance program should be undertaken as documented below. Review the maintenance activities to ensure they are relevant to your drinking water supply. As a minimum these activities should be conducted at the frequency stated below.*

Table 3 has been populated in the ***template document****:*

- *If the frequency is varied to outlined below, amend the timeframe that has been specified*
- *Add or remove the maintenance activities (outlined below) to Table 3 in the* ***template document*** *relevant to your treatment and / or disinfection i.e. filters, UV disinfection, chlorination, pH dosing*
- *Develop a log for recording completed maintenance activities. Examples of documentation are available in Appendix B.*

Table 3: Maintenance program with operational monitoring

Area	Frequency	Activity	Corrective Actions
Bore protection zone	▪ Monthly	▪ Inspect area for anything unusual, e.g., signs of livestock activity, the use or storage of chemicals or fuels, wastewater discharges	▪ Restrict animal access via mechanisms such as fences, etc. ▪ Investigate and remove potential sources of contamination, e.g., chemicals/fuel
Bore	▪ Monthly	▪ Check integrity of bore plinth and casing and any other mechanisms installed to ensure that the bore head is water-tight and protected from surface water flows	▪ Repair or replace any faulty mechanisms designed to prevent the entry of surface water ▪ Repair damaged bore casing and slab/plinth
Bore protection zone	▪ 6 monthly	▪ Check structural integrity of fencing, gates, locks, etc.	▪ Repair any faults
Pump	▪ 6 monthly	▪ Maintain/service pump on an annual basis or as per the manufacturer's recommendations	▪ Repair/replace pump as required ▪ If the pump is removed for maintenance, ensure the top of the bore is blocked to prevent entrance by small animals and other debris
Tank & tank roof	▪ 6 monthly	▪ Check structural integrity of tank including roof and access cover. ▪ Internal inspection to check for evidence of access by animals and	▪ Repair any holes or gaps. ▪ Remove bird /animal carcass and empty and clean tank. Chlorinate if emptying/cleaning tank is not possible.

Area	Frequency	Activity	Corrective Actions
		birds and presence of mosquitoes or larvae. ▪ Internal inspection to check for algal growth ▪ Internal inspection to check for accumulated sediment (to be cleaned every 2 yrs.)	▪ If the bottom of the tank is covered with sediment the tank should be cleaned
Pipework	▪ 6 monthly	▪ Check for structural integrity	▪ Repair pipework as necessary
Pre RO Filters (if present)	▪ Manufacturer's specification	▪ Clean, check and replace filters as per manufacturer's recommendations	▪ Clean filters as required. ▪ Replace or repair filters as required
Reverse Osmosis	▪ Manufacturer's specification	▪ Maintain as per manufacturer's recommendation to avoid problems associated with clogging and microbial growth ▪ Check trans-membrane pressure	▪ Chemical clean of filters as required ▪ Replace or repair filters
	▪ Weekly	▪ Inspect, calibrate online conductivity meter as per manufacturer's requirements.	▪ Calibrate to ensure correct conductivity measurement. Rectify any issues. Repair as necessary.
	▪ 6 monthly	▪ Ensure handheld conductivity meter is maintained as per manufacturer's recommendations	▪ Calibrate handheld conductivity meter. Record results.
UV disinfection (if present)	▪ Daily / Monthly	▪ Where a UV disinfection fault alarm is not available, daily checking is required to ensure unit is operational. ▪ Check for biofilm growth or build-up on UV disinfection lamp sleeves ▪ UV disinfection lamps replaced as required per manufacturer's instructions	▪ If UV disinfection is not operational, stop water immediately and notify SA Health (see Section 5) ▪ Clean sleeves and replace lamps as necessary
Chlorine disinfection	▪ Weekly	▪ Inspect, calibrate, and maintain chlorine dosing equipment as per manufacturer's	▪ Calibrate to ensure correct dose of chlorine. Rectify any issues.

Area	Frequency	Activity	Corrective Actions
		requirements. ▪ Ensure adequate supplies of chlorine. Check use-by dates.	Repair as necessary. ▪ Dispose of out-of-date chlorine and replace as required
	▪ 6 monthly	▪ Ensure handheld chlorine meter is maintained as per manufacturer's recommendations	▪ Calibrate handheld chlorine photometer. Record results.
pH dosing	▪ Weekly	▪ Inspect, calibrate, and maintain chlorine dosing equipment as per manufacturer's requirements.	▪ Calibrate to ensure correct dose of chlorine. Rectify any issues. Repair as necessary.
	▪ Monthly	▪ Ensure adequate supplies of pH dosing chemicals. Check use-by dates.	▪ Dispose of out-of-date chemicals and replace as required
	▪ 6 monthly	▪ Ensure handheld pH meter is maintained as per manufacturer's recommendations	▪ Calibrate handheld pH meter. Record results.

Section 4: Water quality testing

Water quality testing (both laboratory and operational) are used to verify that the water is treated effectively and is safe to drink. The operational monitoring requirements have been divided up into two tables (Table 4.1 and 4.2) This monitoring is conducted on-site. Table 4.3 contains the water quality testing program that is conducted by an approved laboratory. Drinking water providers are responsible for organising the collection of samples and the associated costs for analysis. Analysis of drinking water must be undertaken by a NATA accredited of other laboratory approved by SA Health (a list is available on the SA Health website). Copies of test results must be kept with the RMP, laboratory reports are suitable.

Step 6: *Operational monitoring (both continuous and weekly grab samples) are used to assess whether the system is operating under normal conditions or whether there is an increase in the level of challenge, or the treatment process is not performing effectively. Set up operational monitoring as per detailed outlined in Table 4.1 and 4.2. For the water quality testing program (Table 4.3) sample tap locations are chosen that is representative of the water received by the consumer at its point of use, such as a kitchen tap. Document the sample point locations in the system description and included on your schematic.*

- *Populate Table 4.1, 4.2 and 4.3 in the **template document** to reflect your drinking water supply. Arrange for samples to be analysed as per the prescribed frequency.*
- *Set targets and document alarm set-points in the tables as suggested below. Alarms are set to allow adequate time for response to ensure that a target for a parameter is not exceeded and / or the target of a parameter remains within a prescribed range. Often raw water data and treatment capabilities are used to set targets.*
- *For table 4.2 choose at least two locations in the distribution system to monitor the chlorine residual using a hand-held photometer and conduct the samples as identified in the water quality testing program.*
- *The laboratory results must be reviewed (as outlined in Table 7) and SA Health contacted if required (see Section 5). Copies of the laboratory results are to be kept with the RMP.*

Table 4.1: Continuous operational monitoring

Continuous operational monitoring is used to measure whether the treatment plant is working effectively using online instrumentation. The Water Quality Unit, SA Health and / or water treatment specialist / company can provide assistance in setting targets and alarm set points.

Sample Point	Monitoring	Target	Alarm set-points	Corrective Action
Outlet of RO Plant	▪ Continuous monitoring of permeate conductivity (measure as EC)	▪ Conductivity < 1000 µS.cm^{-1} (TDS ÷ 0.6)	▪ High Alarm: e.g. 850 µS.cm^{-1} ▪ Who responds to the alarm:	▪ Conductivity sensor is alarmed ▪ If conductivity sensor exceeds limits, verify analyser using hand-held unit and check membrane integrity. Plug or replace any broken membranes
RO Plant	▪ Continuous monitoring of trans-membrane pressure	▪ Within manufacturers specification - *seek advice from WQ Unit for setting*	▪ High Alarm: ▪ Low Alarm: ▪ Who responds to the alarm:	▪ Follow manufacturer's instructions for operation and maintenance

Sample Point	Monitoring	Target	Alarm set-points	Corrective Action
		target and alarm set-points		▪ If trans-membrane pressure exceeds design limits, backwash membrane. ▪ If required, carry out chemical clean
pH analyser (if present)	▪ Continuous monitoring of pH analyser	▪ Target range to be set by provider e.g. 7.8 ± 0.2 pH units ▪ ADWG aesthetic guideline 6.5 – 8.5 pH units	▪ High Alarm: e.g. 8.0 pH units ▪ Low Alarm: e.g. 7.2 pH units ▪ Who responds to the alarm:	▪ pH analyser is alarmed ▪ If pH analyser is outside target range, check analyser operation, downstream pH and dosing. Rectify as required.
Chlorine analyser	▪ Continuous monitoring of chlorine analyser	▪ Target range to be set to the provider e.g. 3.0 ± 0.2 mg/L (set target to achieve >0.2 mg/L at the last point in the system) ▪ ADWG Health guideline < 5.0 mg/L	▪ High Alarm: e.g. 4.0 mg/L ▪ Low Alarm: e.g. 2.5 mg/L ▪ Who responds to the alarm:	▪ Chlorine dosing and analyser is alarmed ▪ If chlorine analyser is outside target range, check analyser operation, downstream chlorine residuals and dosing. Rectify as required. ▪ Suggest that chlorine dosing is also alarmed

Table 4.2: Weekly operational monitoring

Weekly operational monitoring is used to check that the online instrumentation (conductivity, chlorine and pH analysers) is accurate and free chlorine is measured, within the set target range, in the distribution system. Regular calibration of online instrumentation is important to ensure the consistent accuracy of an instrument by comparing it with established standards.

Sample Point	Monitoring	Target	Corrective Action
Conductivity analyser	▪ Conductivity measurement using handheld unit	▪ Conductivity < 1000 $\mu S.cm^{-1}$ (TDS ÷ 0.6)	▪ If result is ± 50 $\mu S.cm^{-1}$ repair or calibrate chlorine analyser as required. Seek advice from Water treatment company on calibration on instrument, if required.
Chlorine analyser	▪ Free chlorine residual using handheld unit	▪ Use above chlorine analyser target in table 4.1	▪ If result is ± 0.2 mg/L repair or calibrate chlorine analyser as required. Seek advice from Water treatment company on calibration on instrument, if required.
pH analyser (if dosing)	▪ pH using handheld unit	▪ Use above pH analyser target in	▪ If result is ± 0.5 mg/L repair or calibrate pH analyser as required .Seek advice from Water

Sample Point	Monitoring	Target	Corrective Action
		table 4.1	treatment company on calibration on instrument, if required.
Distribution Location 1 Identify location of sample point	▪ Free chlorine residual using hand-held unit	▪ Target range to be set by the provider	▪ Adjust chlorine dose to ensure adequate disinfection ▪ If chlorine residual <0.2 or ≥ 5 mg/L immediate notification to SA Health is required (See Section 5)
Distribution Location 2 Identify location of sample point	▪ Free chlorine residual using hand-held unit	▪ Target range to be set by the provider	▪ Adjust chlorine dose to ensure free chlorine the end of the distribution system ▪ If chlorine residual <0.2 or ≥ 5 mg/L immediate notification to SA Health is required (See Section 5)

Table 4.3: Water quality testing program – conducted by approved laboratory

Verification monitoring is conducted on a regular basis to check the quality of drinking water at the point of use (e.g. kitchen tap) assessing the performance over a longer period. If a value is exceeded corrective actions should be initiated and SA Health notified of a water quality incident.

The size of the distribution network may require multiple locations to be tested as part of the water quality testing program, see advice from Water Quality Unit, SA Health.

Sample Point	Frequency	Monitoring	Corrective Action
Identify location of sample point (e.g., kitchen tap)	▪ 3 monthly	▪ *E.coli* (multiple locations may be required) ▪ Total Dissolved Solids or conductivity (1 Location) ▪ pH (1 location)	If *E.coli i*s detected: ▪ UV disinfection or chlorination is not working and requires immediate investigation. ▪ Post-treatment storage tanks (if present) should be disinfected with chlorine (see Appendix A) ▪ Notify as a water quality incident (see Section 5) If TDS / conductivity and pH guideline values are exceeded (see Appendix C) ▪ Review treatment processes ▪ Notify as a water quality incident (see Section 5)
	▪ 2 yearly	▪ Health related chemical parameters (1 location)	If chemical guideline values are exceeded (see Appendix C) ▪ Notify as a water treatment incident (see Section 5). Advice on further action and corrective responses should be sought from DHA

Section 5: Incident identification and notification protocol

An RMP prepared by a drinking water provider must include an approved incident identification and notification protocol. The protocol described in Table 5 is taken to be approved where adopted by a drinking water provider supplying bore water.

Step 7: *Tables 5 and 6 have been populated in the **template document**. Include details for UV or chlorine disinfection depending on type of disinfection in use.*

Table 5: Incident identification and notification protocol

Parameter	Criteria	Notification requirements to SA Health
E.coli	▪ Any detection of *E.coli* per 100 mL sample of water	Immediate notification to SA Health on **0421 618 311** AND incident notification form is submitted within 24 hours via email waterquality@sa.gov.au.
Total Dissolved Solids or Conductivity	▪ Detection ≥ 600 mg/L (or EC ≥ 1000µS.cm^{-1})	
pH	▪ Detection ≤ 6.5 or ≥ 8.5 pH units	
Health and Aesthetic chemicals	▪ Any exceedance of the ADWG values (see Appendix C for guideline values) for the following parameters: Antimony, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Copper, Fluoride, Lead, Manganese, Mercury, Molybdenum, Nickel, Nitrate, Selenium, Silver, Sulfate and Uranium, Hardness ($CaCO_3$), Iron, Zinc	
Contamination of bore water supply	Suspected contamination due to: ▪ A dead animal in treated water storage tank ▪ Wastewater discharge, flooding or other surface water ingress (where tank or pipework underground)	
Undefined incident	▪ Any other incident (not defined above) or where specific concerns exist over the quality of the drinking water supply	
Reverse Osmosis failure	▪ Any failure of the RO unit	
Chlorination – overdose	▪ Overdosing producing a chlorine residual >5 mg/L	
Chlorination failure	▪ Chlorination failure resulting in chlorine residual <0.2mg/L (measured immediately after the dosing point)	

Incident response

If any of the criteria in Table 5 are confirmed for your drinking water supply:

- Contact Water Quality Unit, SA Health immediately on **0421 618 311**
- Undertake immediate remedial actions (see Table 6). Use packaged water while corrective action is taken.
- Complete the SA Health Water Quality Incident notification form available from the SA Health website. Documenting the corrective actions taken.
- Submit the completed form within 24 hours to Water Quality Unit, SA Health via email waterquality@sa.gov.au

Table 6: Immediate remedial actions for typical water quality incidents

WQ Incident	Corrective Actions
Detection of *E.coli*	▪ Undertake an inspection of the bore, catchment area, RO unit, post-treatment storage tank and distribution system to identify any potential sources of contamination. ▪ Check that the RO treatment, UV disinfection unit or chlorinator is working ▪ Implement any immediate remedial action as required, e.g., water pooling at base of the bore. ▪ Disinfect the treated water storage tank with chlorine (see Appendix A for information on the procedure and information on calculating doses). ▪ Ensure chlorinated water is flushed through all pipework.
Loss or overdose of chlorine disinfection	▪ Measure the free chlorine residual at the point of use and check the chlorine analyser (immediately after dosing) ▪ If free chlorine is less than 0.2mg/L o Reinstate chlorination (if failure detected) or increase chlorine dosing and flush any undisinfected water from the system. ▪ If free chlorine is greater than 5 mg/L o Reduce chlorine dose and flush the system to remove water with elevated chlorine. ▪ Closely monitor equipment and calibrated (if necessary)

Section 6: Management and record keeping

To ensure your drinking water supply remains safe to drink, activities required to manage your water supply must be documented including inspections and maintenance, water quality results and incident management.

Step 8: *Identify the personnel in your business that are responsible for fulfilling the activities outlined in the RMP. Multiple tasks may be assigned to the same individual. Populate Table 7 in the* ***template document.***

Table 7: Responsibility table

RMP review	Who updates the RMP document when required?
Maintenance activities	Who undertakes maintenance activities?
Operational monitoring	Who undertakes operational monitoring sampling (online and weekly)?
Water quality sampling	Who undertakes water quality sampling for laboratory analysis?
Review of water quality test results and notification to SA Health if required	Who reviews water quality test results and notifies SA Health if required?
Corrective action in response to water quality incident	Who undertakes any corrective actions in response to a water quality incident?
Record keeping location	Document where your RMP, maintenance records, water quality testing data and incident notification forms are kept

Record Keeping

Step 9: *Establish a record keeping system that is easily accessible, such as a folder of printed documents or electronic files, to allow for quick reference during a water quality incident and for review during an inspection. The record keeping system should include your approved RMP and records of maintenance activities, water quality results, incident notification forms and details of corrective actions. Record keeping templates are provided in Appendix B*

Additional information is available from:

- SA Health Website – Providing safe drinking water including specific information on bore water
- Bore construction information is available in the document 'Minimum construction requirements for water bores in Australia'

Appendix A: Additional Treatment options

Boiling

Where contamination of bore water is suspected or where additional precautions are considered necessary boiling of undisinfected bore water will ensure microbial safety. For example, people with lower immune responses, such as the very young or very old, cancer patients, people with diabetes, organ transplants or those who are HIV positive should consider boiling bore water prior to consumption. Boiling should also be considered if gastric upsets e.g., vomiting and diarrhoea occur. Boiling also provides a disinfection option for water provided to the public, including use in food preparation, as an assurance of safety.

Bringing water to a boil will achieve disinfection. Boiling does not have to be maintained for any length of time – kettles with automatic shutoffs are suitable for this purpose. Boiling the water will kill any harmful bacteria, viruses or protozoa including *Giardia* and *Cryptosporidium*. Boiled water can be cooled and stored in a clean container until use. The taste of boiled water can be improved by pouring it back and forth from one clean container to another or letting it stand for a few hours to increase the dissolved oxygen concentration.

Care should be taken when boiling water, particularly large quantities, to avoid the risk of scalding.

Emergency chlorination

Regular manual chlorination of bore water held in tanks is generally only recommended as a remedial action. The effectiveness of chlorine is short-lived, and it will only act on the water in the tank at the time of dosing. Fresh flows of water into the tank after chlorination will probably not be disinfected.

To achieve effective disinfection, it is necessary to add sufficient chlorine to provide a free chlorine residual of at least 0.5mg/L after a contact time of 30 minutes. This can be measured using a suitable chlorine test kit, e.g., a swimming pool kit. As a general guide, to achieve a chlorine dose of approximately 5mg/L you will need to add:

- 40ml of liquid sodium hypochlorite (12.5% available chlorine) per 1000L of water
- 7g of granular calcium hypochlorite (70% available chlorine) per 1000L of water

Further guidance on determining the size of bore water tanks for chlorination and for specific amounts of chlorine for various volumes of water is below.

Calcium hypochlorite should be dissolved in water, in a clean plastic bucket, in the open air, before adding it to the tank. Always add the disinfectant to the water rather than vice versa. When adding the chlorine to the tank, spread it as widely across the surface as possible to promote mixing and let it stand for at least one hour before use. Pipework should be flushed with the chlorinated water.

Sodium and calcium hypochlorite and chlorine test kits can be purchased from large supermarkets, hardware stores or swimming pool stockists. The two forms of chlorination should **never be mixed** as this can cause explosions**.** The chlorine will not make the water unsafe to drink but you may notice a distinct taste and odour that should disappear in 10 to 14 days. Boiling the water will remove most of the taste and odour associated with chlorine.

Calculations to determine the volume of water in a tank

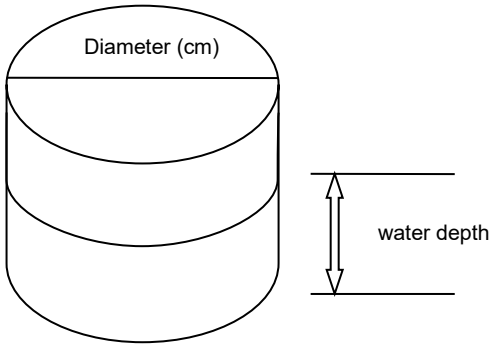
To calculate the volume of a rectangular tank, use the formula:

- Volume (in litres) = depth (cm) x width (cm) x length (cm) ÷ 1000

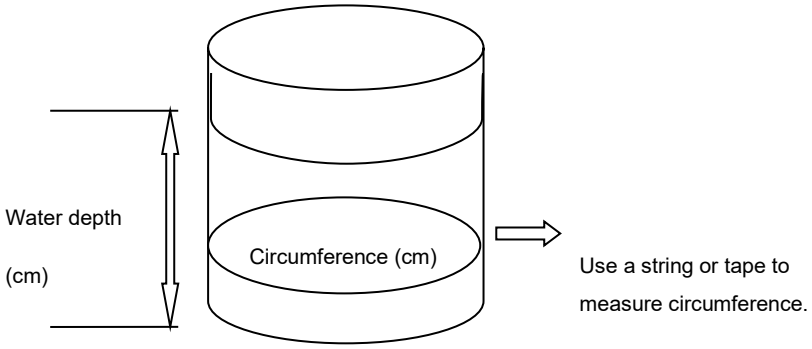
To calculate the volume of a cylindrical tank either use the formula:

- Volume (in litres) = π x diameter^2 (cm^2) x depth (cm) ÷ 4000 (where π = 22 ÷ 7)

OR use one of the following methods, **remember to calculate the volume of water in the tank and not the volume of the tank:**



FORMULA 1: Volume (in litres) = 0.8 x water depth (cm) x diameter^2 (cm^2) ÷ 1000



FORMULA 2: Volume (in litres) = 0.08 x water depth (cm) x circumference^2 (cm^2) ÷ 1000

Chlorine doses

To achieve 5 mg/L of free chlorine, use the following measurements (mL or g) of hypochlorite (liquid or granular) assigned for the tank volume (calculated above).

Remember to calculate the volume of water in the tank not the volume of the tank.

Chlorine Concentration	**5 mg/L**	
Tank Volume (L)	**12.5% liquid Sodium Hypochlorite**	**70% granular Calcium Hypochlorite**
	mL	**g**
1000	40	7
2000	80	14
3000	120	21
4000	160	28
5000	200	35
6000	240	42
7000	280	49
8000	320	56
9000	360	63
10000	400	70
11000	440	77
12000	480	84
13000	520	91
14000	560	98
15000	600	105
16000	640	112
17000	680	119
18000	720	126
19000	760	133
20000	800	140

Appendix B: Record Keeping for template documents

These are suggested template documents to be used as part of your record keeping for maintenance activities (see Section 3). If maintenance activities are recorded via a different method/records system, please ensure all activities relevant to your supply listed below are captured

Maintenance Activities template document

*Modify as required to align with Table 3 in the **template document**. If the frequency varies for the task consider using multiple tables.*

Safe Drinking Water Act 2011 **- Maintenance program (as per manufacturers specification)**

Observations and actions (if taken) during scheduled inspections.

Area	**Inspection**	**Date:**	**Date:**	**Date:**	**Date:**
		Name:	**Name:**	**Name:**	**Name:**
Pre-RO filters	Clean / replace filters				
RO trans-membrane pressure	Check RO trans-membrane pressure and follow manufacturer's instructions for operation and maintenance				
RO membranes	Undertake chemical clean of RO membranes				
	Replace RO membranes as required				

Safe Drinking Water Act 2011 **- Maintenance program (weekly)**

Observations and actions (if taken) during scheduled inspections.

Area	**Inspection**	**Date:**	**Date:**	**Date:**	**Date:**
		Name:	**Name:**	**Name:**	**Name:**
Conductivity analyser	Check permeate conductivity measurement using handheld unit. Calibrate / repair if required				
Chlorine analyser	Check chlorine analyser measurement using handheld unit. Calibrate / repair if required				
pH analyser	Check chlorine analyser measurement using handheld unit. Calibrate / repair if required				
Chlorine stocks	Check chlorine expiry dates and stock levels				

Safe Drinking Water Act 2011 **- Maintenance program (Monthly)**

Observations and actions (if taken) during scheduled inspections.

Area	**Inspection**	**Date:**	**Date:**	**Date:**	**Date:**
		Name:	**Name:**	**Name:**	**Name:**
Bore Protection Zone	Inspect area for anything unusual, e.g. signs of livestock activity, the use or storage of chemicals or fuels, wastewater discharges				
Bore	Check integrity of bore plinth and casing and any other mechanisms installed to ensure that the borehead is water-tight and protected from surface water flows				
UV disinfection	Check for biofilm growth or build-up on UV disinfection lamp sleeves				
	Check operation of fault alarm				
	Check and record date until lamp replacement (as per manufacturer's instructions)				
pH dosing chemical stocks	Check chemical expiry dates for pH dosing and stock levels				

Safe Drinking Water Act 2011 **- Maintenance program (6-Monthly)**

Observation and actions (if taken) during scheduled inspections

Area	**Inspection**	**Date:**	**Date:**	**Date:**	**Date:**
		Name:	**Name:**	**Name:**	**Name:**
Bore Protection Zone	Check structural integrity of fencing, gates, locks, etc.				
Pump	Maintain/service pump as per the manufacturer's recommendations				
Tank and tank roof	Check structural integrity of tank including roof and access cover.				
	Internal inspection to check for evidence of access by animals and birds and presence of mosquitoes or larvae.				
	Internal inspection to check for algal growth				
	Internal inspection to check for accumulated sediment				
Pipework	Check for structural integrity				
RO treatment	Ensure handheld conductivity meter is maintained as per manufacturer's recommendations				
Chlorine	Ensure handheld chlorine meter is maintained as per manufacturer's recommendations				
pH dosing	Ensure handheld pH meter is maintained as per manufacturer's recommendations				

Safe Drinking Water Act 2011 **- Maintenance program (2 yearly)**

Observations and actions (if taken) during scheduled inspections.

Area	**Inspection**	**Date:**	**Date:**	**Date:**	**Date:**
		Name:	**Name:**	**Name:**	**Name:**
Tank	Clean tank to remove any accumulated sediment				

Safe Drinking Water Act 2011 **- UV disinfection unit daily visual check**

UV disinfection details:_____

Week Beginning (Date)	**Sun**	**Mon**	**Tues**	**Wed**	**Thurs**	**Fri**	**Sat**

Safe Drinking Water Act 2011 **- Weekly chlorine residual measurements**

Operating targets

Sample Point Location	**Free chlorine residual (mg/)**
Location 1(i.e. Tank)	*1.5 ±0.5 mg/L*
Location 2 (i.e. Kitchen tap)	*1.0 ±0.5 mg/L*

Date:	**Free chlorine for Sample locations**		**Calibration of handheld unit complete?**	**Sodium hypochlorite in date?**	**Checked by:**
	Location 1 ***(mg/L)***	***Location 2*** ***(mg/L)***	**(Yes / no)**	**(Yes / no)**	

Appendix C: Health and Aesthetic Chemical Parameters

Health-related chemical parameters in drinking water should be less than the Australian Drinking Water Guideline 2011, Version 4.0 (ADWG) values in the table below.

Chemical	ADWG Health value (mg/L)	ADWG Aesthetic value (mg/L)
Antimony	0.003	-
Arsenic	0.01	-
Barium	2	-
Beryllium	0.06	-
Boron	4	-
Cadmium	0.002	-
Chromium	0.05	-
Copper	2	1
Fluoride	1.5	-
Hardness (as $CaCO^3$)	-	200
Iron	-	0.3
Lead	0.005	-
Manganese	0.1	0.05
Mercury	0.001	-
Molybdenum	0.05	-
Nickel	0.02	-
Nitrate	50	-
pH	-	pH 6.5 – 8.5
Selenium	0.004	-
Silver	0.1	-
Sulfate	-	250
Total Dissolved Solids	-	600
Uranium	0.02	-
Zinc	-	3

For the latest version of the ADWG go to:

http://www.nhmrc.gov.au/guidelines/publications/eh52

For more information

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