Proposed edits and corrections to the *Australian Drinking Water Guidelines*

The following tables present a number of proposed text amendments to the Australian Drinking Water Guidelines (Version 4.0):

- **Table 1**: Proposed amendments to **Chapter 5 – Microbial Quality of Drinking Water**
- **Table 2**: Proposed amendments to **Appendix 3 - *Derivation of microbial treatment targets for enteric pathogens***
- **Table 3:** Proposed amendments to selected **ISO/AS NZS Standards**
- **Table 4:** Proposed '**other' amendments** throughout the Guidelines (e.g. terminology, updates to references, calculation corrections)

Proposed text edits are shown in **bold** and highlighted in yellow. Each relevant section includes a link to the HTML version of the Guidelines, with the corresponding PDF page number also indicated.

Table 1: Proposed amendments to Chapter 5 – Microbial Quality of Drinking Water

No.	Section of Guidelines	Current Guidelines text (V4.0)	Proposed Guidelines text (V4.1)
1	Visit Chapter 5.1 Introduction of the Guidelines (p73 of PDF)	This chapter discusses the microbial characteristics of drinking water and provides quantitative health-based targets for assessing microbial risk. It describes the health risks from disease causing microorganisms (pathogens) and toxic cyanobacteria that may be **found** in drinking water. The important concepts relating to assessing microbial risk are set out in Section 5.3. The principles and approach for assessing the contamination of source waters and management of those risks are set out in Sections 5.4, 5.5 and 5.6. Adoption of these concepts should be integrated through the 12 Element Framework	This chapter discusses the microbial characteristics of drinking water and provides quantitative health-based targets for assessing microbial risk. It describes the health risks from disease causing microorganisms (pathogens) and toxic cyanobacteria that may be **present** in drinking water. The important [***unchanged text omitted***] Chapter 3 (see Box 5.1). **The implementation of microbial health-based targets provides the basis for assessing and determining the level of treatment needed to manage the microbial risks (i.e. enteric pathogens) associated with the source water. The annual microbial health-based target has been set at one in a million disability adjusted life years per person per year for the total population (1 µDALY pppy) and is considered to be a tolerable level of risk in the provision of safe drinking water.**

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		for Managing Drinking Water Quality outlined in Chapter 3 (see Box 5.1).	The required level of treatment to achieve this microbial health-based target is expressed on a logarithmic scale (log_{10}) and is related to the removal of reference pathogens as determined by a quantitative microbial risk assessment (QMRA). These treatment targets are expressed as Log Reduction Values (LRVs) and vary between different categories of source water. Water-based pathogens (e.g. *Legionella pneumophila*, non-tuberculous mycobacteria) that grow to problematic levels post treatment in pipe biofilms are managed by disinfectant residual, flushing and other controls (NAS 2020; LeChevallier 2024).
2	Visit Chapter 5, Box 5.1 Integrating health-based targets into the Framework for Managing Drinking Water Quality of the Guidelines (p73 of PDF)	**Integrating health-based targets into the Framework for Managing Drinking Water Quality (Chapter 3)** Health-based targets provide a quantitative measure of the microbial safety of drinking water. The *Australian Drinking Water Guidelines* (the Guidelines) promote preventive risk-based management of drinking water quality from source to consumer with the Framework for Managing Drinking Water Quality (Chapter 3). Health-based targets provide an assessment of enteric pathogen risks in the source water and inform appropriate risk management measures (barriers). These assessment and preventive measures support Elements 2 and 3 of the Framework. It is expected that implementing health-based targets into drinking water management, particularly for small water suppliers, will take time. Health-based targets are not a pass/fail metric, instead they provide the basis for assessing the level of treatment required to manage source water microbial risks. Shortfalls in achieving the required treatment targets (expressed as log_{10} reduction values or LRVs) to manage source water pathogen risks	**Integrating microbial health-based targets into the Framework for Managing Drinking Water Quality (Chapter 3)** The *Australian Drinking Water Guidelines* (the Guidelines) promote preventive risk-based management of drinking water quality from source to consumer with the Framework for Managing Drinking Water Quality (Chapter 3). Microbial health-based targets provide a quantitative assessment of enteric pathogen risks in the source water and inform appropriate risk-based barriers. These assessment and preventive measures support Elements 2 and 3 of the Framework. It is expected that implementing microbial health-based targets into drinking water management, particularly for small water suppliers, will take time. Microbial health-based targets are not a pass/ fail metric, instead they provide the basis for assessment of microbial safety of drinking water, including assessment of catchment risks and water treatment requirements. Consistent with the principles of preventive risk management, focus should be maintained on selecting the best quality source water, catchment protection, multiple barriers and management of critical control points. Integrating microbial health-based targets into the broader water quality management framework provides a methodology to better align key focus areas. Microbial health-based

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		should be used to prioritise improvements (see Section 5.4.3 *Management of Risk from Enteric Pathogens: Microbial Safety and the Water Safety Continuum*). Focus should be maintained on selecting the best quality source water, catchment protection, multiple barriers and management of critical control points. The introduction of health-based targets should not take focus away from the guiding principles of the Guidelines (see Section 1.1) and implementing all 12 Elements of the Framework for Management of Drinking Water Quality. The introduction of health-based targets must not be used as a licence to degrade source water quality. This chapter addresses the overarching scientific principles and concepts. A detailed guide for practical implementation is beyond the scope of the Guidelines. Further practical details can be found in the following suggested industry implementation documents, noting that there might be some costs associated with accessing these: • Deere and Mosse (2016) Water Industry Operators Association of Australia: *Practical guide to the operation and optimisation of distribution systems*, 3rd ed. • Water Research Australia (WaterRA 2015) *Good practice guide to the operation of drinking water supply systems for the management of microbial risk*. • Water Research Australia (WaterRA 2021), *Good practice guide to sanitary surveys and operational monitoring to support the assessment and management of drinking water catchments*.	targets must be applied within the context of the guiding principles (refer to Section 1.1) and all 12 Elements of the Framework for Management of Drinking Water Quality. Microbial health-based targets must never be used as a basis to degrade source water quality or diminish treatment efficacy. The following key principles need to be considered in the implementation of health-based targets: • adherence to microbial health-based targets should not be assessed as a pass/fail or used to determine regulatory compliance • microbial health-based targets are a performance indicator intended to inform system-specific interventions appropriate to delivering microbially safe drinking water, including control measures such as source protection and treatment processes • shortfalls in achieving the required treatment targets (expressed as $\log_{10}$ reduction values or LRVs) to manage source water pathogen risks should be used to prioritise improvements (see Section 5.4.3 Management of Risk from Enteric Pathogens: Microbial Safety and the Water Safety Continuum) • not meeting the microbial health-based targets indicates that the risk is unacceptable and operational improvements or additional barriers may need to be implemented • microbial health-based targets are not suitable for use as an operational basis for assessing public health risk of hazardous events (e.g. decisions underpinning incident and emergency response). Microbial health-based targets do not operationally ensure that pathogen reduction is maintained as expected. Barrier assurance is provided through operational monitoring and compliance with performance criteria and critical limits,

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		• Water Services Association Australia (WSAA 2015) *Manual for the application of health-based targets for drinking water safety*. • World Health Organization (WHO) (WHO 2016) *Protecting surface water for health. Identifying, assessing and managing drinking-water quality risks in surface-water catchments*.	**underpinned by good operational practices and supporting programs.** This chapter addresses the overarching scientific principles and concepts. A detailed guide for practical implementation is beyond the scope of the Guidelines. Further practical details can be found in the following industry implementation documents, noting that there might be some costs associated with access: • Deere and Mosse (2016) Water Industry Operators Association of Australia: *Practical guide to the operation and optimisation of distribution systems*, 3rd ed. • Hamilton KA, Quon H, Nisar MA, Jahne M, Garland J, Davis B, Williams C, Ashbolt NJ, Eisenberg JNS, Zhang Q, Ishii S (2025). *Next generation Quantitative Microbial Risk Assessment (QMRA): Bigger, better, faster.* ACS ES&T Lett 12(11):1471–1480. https://doi.org/10.1021/acs.estlett.5c00782. • Hamilton KA, Quon H, Ashbolt NJ, Gurian PL, Reynaert E, Haas CN, Morgenroth E, Wilson AM (2026). *Making Waves: Moving beyond the 1 in 10,000 benchmark in quantitative microbial risk assessment (QMRA) through evidence-informed risk approaches and systems decision-making*. Water Research 289:124903. https://doi.org/10.1016/j.watres.2025.12490 • Roser DJ, Ashbolt NJ (2007). *Source Water Quality Assessment and the Management of Pathogens in Surface Catchments and Aquifers*. Research Report 29, CRC for Water Quality and Treatment, Salisbury, SA. • WaterRA (2015). *Good practice guide to the operation of drinking water supply systems for the management of microbial risk.* Research Project 1074, Water Research Australia, Adelaide, SA.

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			• WaterRA (2021). *Good practice guide to sanitary surveys and operational monitoring to support the assessment and management of drinking water catchments.* Final Report to Project 1109. Water Research Australia Research, Adelaide, SA. • Westgate S, Robertson M (2018). A new approach to assessing water quality risk. Water e-Journal 3(3):1–9. • World Health Organization (WHO) (2016). *Protecting surface water for health. Identifying, assessing and managing drinking-water quality risks in surface-water catchments*.
3	Visit Chapter 5.2 Microorganisms in drinking water of the Guidelines (p74 of PDF)	**5.2 Microorganisms in drinking water** Microorganisms that may be present in drinking water are grouped into the following five categories: **Bacteria:** are single cell microorganisms. Bacteria harmful to human health such as *Campylobacter* and *Salmonella* are generally unable to replicate in raw and treated drinking water. Non-pathogenic bacteria may produce "endotoxins" that can trigger symptoms in susceptible people if ingested, inhaled or in contact with the skin at sufficient concentrations. The reference pathogen used for bacteria in these Guidelines is *Campylobacter*. **Viruses:** are made up of a core of nucleic acid (RNA or DNA) surrounded by a protein coat, and in some cases a lipoprotein envelope, that helps the viruses to attach to and enter host cells so they can replicate. Although they cannot reproduce without the host cell, they can survive in the environment for extended periods of time. No single virus satisfies all requirements of a reference pathogen. As a result, the reference virus included in the	**5.2 Microorganisms in drinking water** Microorganisms that may be present in drinking water are grouped into the following five categories: **Bacteria** are single cell procaryotic microorganisms that include filamentous cyanobacteria and actinomyces. Enteric bacteria harmful to human health such as *Campylobacter* and *Salmonella species* (spp.) are generally unable to replicate in raw and treated drinking water. The reference pathogen used for enteric bacterial pathogen management in these Guidelines is *Campylobacter jejuni*. Non-pathogenic bacteria may produce "endotoxins" that can trigger symptoms in susceptible people if ingested, inhaled or in contact with the skin at sufficient concentrations. However, no health-based target is set for the range of bacteria that contributes to the presence of endotoxin. Other toxins produced by cyanobacteria are addressed in Chapter 3 and Part V fact sheets on toxic cyanobacteria and their toxins. **Viruses** are acellular infectious but non-living microorganisms made up of a core of nucleic acid (RNA or DNA) surrounded by a protein coat, and in some cases a lipoprotein envelope, that helps the viruses to attach to and enter host cells so they can replicate. Although they

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		Guidelines is derived from a combination of different virus characteristics (Regli et al. 1991) including occurrence data for adenovirus and dose-response data for norovirus. Further information on the reference virus is provided in Appendix A3.5. **Protozoa:** are single cell microorganisms that may cause adverse health effects and can live as parasites in the guts of humans and other mammals. These may form persistent cysts or oocysts that are resistant to environmental stress and are unable to grow in the environment. They may also exist as free-living organisms that may cause serious disease in humans (e.g. *Naegleria fowleri*). The reference pathogen used for protozoa in these Guidelines is *Cryptosporidium*. **Helminths:** are invertebrates that can be transmitted via water as microscopic eggs. While transmission by drinking water is plausible, other routes of infection are typically more common (WHO 2017). The major helminth (worm) parasites of humans listed by the WHO as being transmitted by water are *Dracunculus* (WHO 2011a) but they are not endemic in Australia. Due to the relatively large physical size of helminth eggs, the management of protozoan pathogens would also manage helminths. For this reason, protozoa are used as a surrogate reference pathogen for helminths. There is no specific consideration of helminths in drinking water in the Australian context. **Fungi:** include organisms such as single-celled yeasts and multi-cellular filamentous fungi. Many fungal species can survive in low nutrient (oligotrophic) environments, through scavenging nutrients from the substrate which	cannot reproduce without the host cell, they can **remain infectious** in the environment for extended periods of time. No single virus satisfies all requirements of a reference pathogen. As a result, the reference virus included in the Guidelines is derived from a combination of different virus characteristics (Regli et al. 1991) including occurrence data for adenovirus **in sewage** and dose-response data for norovirus **infection.** Further information on the reference virus is provided in Appendix A3.5. **Protozoa** are single cell **eukaryotic** microorganisms that may cause adverse health effects and can live as parasites in the guts of humans and **various animals (predominantly** other mammals**/birds)**. These may form persistent cysts or oocysts that are resistant to environmental stress**ors** and **disinfectants, but parasitic protozoa are obligate parasites that require other hosts** to grow. The**re are** also free-living **protozoa**, that may cause serious disease in humans (e.g. *Naegleria fowleri*). The reference pathogen used for **parasitic** protozoa in these Guidelines is *Cryptosporidium **hominis***. **Helminths** are **macroscopic** invertebrates that can be transmitted via water as microscopic eggs **(ova) from human/animal excreta**. While transmission by drinking water is plausible, other routes of infection are typically more common (WHO 2017). The major helminth (worm) parasites of humans listed by the WHO as being transmitted by water are *Dracunculus* (WHO 2011a), but they are not endemic in Australia. Due to the relatively large physical size of helminth eggs **and generally low concentration in waters compared to parasitic protozoa**, the management of **parasitic** protozoa would also manage helminths. For this reason, **parasitic** protozoa are used as a surrogate for helminth **removals, and there is no specific microbial health-based target for helminths in the Guidelines**. **Fungi** include **eukaryotic micro**organisms such as single-celled yeasts and multi-cellular filamentous **moulds**. Many fungal species can

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		they colonise, or the air or water in which they live (heterotrophic). The occurrence and health implications of fungi in drinking water systems have been reviewed in the United Kingdom (De Toni and Reilly 2011). Relatively few studies have investigated the fungi found in treated drinking water and this topic remains poorly understood. Many of the fungal species that have been isolated from treated drinking water include potentially pathogenic strains. However, generally the highest risk from fungi is through airborne transmission to immunocompromised individuals. While healthy individuals may suffer from superficial or localised fungal infections, there is little evidence that drinking water is a significant source of infection (De Toni and Reilly 2011). Chemicals produced by fungi (growing in water distribution and plumbing systems) may change the taste and odour of drinking water, but do not necessarily pose a health risk. Fungi are not considered a significant health risk in drinking water. There is no reference pathogen for fungi in drinking water.	survive in low nutrient (oligotrophic) environments, through scavenging nutrients from the substrate which they colonise, or the air or water in which they live (heterotrophic). The occurrence and health implications (**from allergies, infections, mycotoxins**) of fungi in drinking water systems have been reviewed (De Toni and Reilly 2011, **Sammon et al. 2010, Sammon et al. 2011, Wan et al. 2023, Zhou et al. 2022**). **However,** relatively few studies have investigated the fungi found in treated drinking water and this topic remains poorly understood. Many of the fungal species that have been isolated from treated drinking water include potentially pathogenic strains. However, generally the highest risk from fungi is through airborne transmission to immunocompromised individuals. While healthy individuals may suffer from superficial or localised fungal infections, there is little evidence that drinking water is a significant source of infection (De Toni and Reilly 2011). Chemicals produced by fungi (growing in water distribution and plumbing systems) may change the taste and odour of drinking water, but do not necessarily pose a health risk **except for known mycotoxins (Zhao et al. 2022). Hence**, fungi are **generally** not considered a significant health risk in drinking water, **yet secondary disinfection may provide additional protection to vulnerable individuals in healthcare settings (Zhao et al. 2022)**. There is no reference pathogen for fungi in drinking water **although removals/inactivation of oocysts of *Cryptosporidium hominis* would be expected to provide protection from fungal spores at the point of water treatment.**
4	Visit Chapter 5.2 Microorganisms in drinking water of the Guidelines (p75 of PDF)	Pathogens can be shed from infected hosts via excreted faeces and vomit in very large numbers, often billions per day. Many are rapidly inactivated in water, but some can persist in water and soil for months or even years under favourable environmental conditions.	Pathogens can be shed from infected hosts via excreted faeces and vomit in very large numbers, often billions per day. Many are rapidly inactivated in water, but some can persist in water and soil for months or even years under favourable environmental conditions.

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		Based on their transmission pathways and health impacts, microorganisms of concern in drinking water can be divided into three groups: **Enteric pathogens**: are microorganisms that cause infection in the gastrointestinal tract of humans and/or animal hosts and are excreted in large numbers in faeces and in vomit. These "faecal-oral" pathogens can persist in the environment and be transported to source waters that might be used for drinking water. If left unmanaged, these pathogens can potentially lead to new infections in any exposed population. The most common and widespread public health risk associated with drinking water is contamination by pathogens from human or animal faeces. Management of enteric pathogens involves: • protecting of source waters from faecal contamination • reducing the burden on treatment systems with water storage and selective abstraction of source water to avoid taking lower quality water • treating water to remove or inactivate any remaining pathogens • monitoring and protecting the distribution system to prevent recontamination or regrowth. **Opportunistic pathogens:** are microorganisms that occur naturally and may cause disease opportunistically in humans depending on the exposure scenario. The risk to health from these microorganisms is typically low at the concentrations likely to occur in natural	Based on their transmission pathways and health impacts, microorganisms of concern in drinking water can be divided into three groups: **1. Enteric pathogens:** are **viral, bacterial and protozoan** microorganisms that cause infection in the gastrointestinal tract of humans and/or animal hosts and are excreted in large numbers in faeces and in vomit. These "faecal-oral" pathogens can persist in the environment and be transported to source waters that might be used for drinking water. If left unmanaged, these pathogens can potentially lead to new infections in any exposed population. The most common and widespread public health risk associated with drinking water is contamination by pathogens from human or animal faeces **(Ashbolt 2015a).** Management of enteric pathogens involves: • protecting of source waters from faecal contamination • reducing the burden on treatment systems with water storage and selective abstraction of source water to avoid taking lower quality water • treating water to remove or inactivate any remaining pathogens **to meet HBTs** • monitoring and protecting the distribution system to prevent recontamination or regrowth. **2. Water-based (saprozoic) pathogens:** are microorganisms that occur naturally **in aquatic environments** and may cause disease opportunistically in humans depending on the **human vulnerability and** exposure scenario **(Ashbolt 2015b).** The risk to health from these microorganisms is typically low at the concentrations likely to occur in natural environmental waters (with low nutrient concentrations). However, in distribution and

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		environmental waters (with low nutrient concentrations). However, in distribution and plumbing networks where conditions are suitable, opportunistic pathogens (e.g. *Aeromonas*, *Pseudomonas*) can grow to very high concentrations that may cause harm, particularly to susceptible population groups. Favourable conditions such as biofilms in water supply systems can also lead to microbial communities that support the proliferation of pathogenic amoebas (e.g. *Naegleria fowleri*). *Naegleria fowleri* is a free-living amoeba that can enter the central nervous system via the nasal cavity and cause primary amoebic encephalitis (PAM). While extremely rare, PAM is almost always fatal. Management of opportunistic pathogens involves: • treating water to remove or inactivate pathogens • managing water quality in the distribution and plumbing network • preventing conditions that support microbial growth or allow recontamination to occur (e.g. minimising stagnation, maintaining effective disinfection residuals and low nutrient levels). **Cyanobacteria:** are true bacteria, although they are sometimes termed "blue-green algae" because they resemble true algae. Some cyanobacteria can produce toxins (cyanotoxins) that are harmful to human health. The cell walls of most cyanobacteria contain polysaccharides that may cause skin irritation. Part V contains fact sheets on toxic cyanobacteria and their toxins.	plumbing networks where conditions are suitable, **opportunistic premise plumbing pathogens** (e.g. ***Legionella***, *Aeromonas* **spp.**, ***Acinetobacter baumannii***, *Pseudomonas* ***aeruginosa***, ***Stenotrophomonas maltophilia*** and nontuberculous mycobacteria) **(Whiley et al. 2014; Hayward et al. 2025)** can grow to very high concentrations that may cause harm, particularly to susceptible **individuals, e.g. drinking water associated pathogens can cause infections in immunocompromised individuals (Proctor 2022).** Favourable conditions such as **warm** biofilms in **the** water supply systems can also lead to microbial communities that support the proliferation of pathogenic amoebae (e.g. *Naegleria fowleri,* ***Acanthamoeba*** **spp.) (Miller *at al.* 2018) that support the growth of opportunistic pathogens (Ashbolt 2015b).** *N. fowleri* is a free-living amoeba that can enter the central nervous system via **forced water flow into** the nasal cavity and causes primary amoebic encephalitis (PAM). While extremely rare, PAM is almost always fatal **as not typically diagnosed until autopsy (Ghosh et al. 2025) and various amoeba can be involved (Bellini et al. 2022. In addition, opportunistic free-living amoebae such as *Acanthamoeba* spp. and *Vermamoeba vermiformis* pose a dual risk by acting as opportunistic pathogens themselves and by serving as environmental hosts that protect and enhance the persistence of bacterial pathogens, including *Legionella pneumophila* and *Mycobacterium* spp., within drinking water systems (Thomas et al 2010; Nisar et al 2022).** Management of opportunistic pathogens involves: • treating water to remove or inactivate pathogens • managing water quality in the distribution and plumbing network • preventing conditions that support microbial growth or

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		Management of cyanobacteria involves: • minimising nutrient inputs into source waters • avoiding water from the surface layer of stratified water bodies • promoting water movement (e.g. through mixing) in unstratified water bodies • treating water to remove cyanobacterial cells and taste and odour compounds and inactivate cyanotoxins. Other pathogens that primarily cause infections of the respiratory system, skin, eyes or other organ systems can be spread via drinking water. In practice the processes for managing enteric pathogen risks will also control these pathogens if residual disinfection is maintained. These pathogens are discussed further in Section 5.5 and in the corresponding fact sheets in Part V.	allow recontamination to occur (e.g. minimising stagnation, maintaining effective disinfection residuals and low nutrient levels). **3. Cyanobacteria** are true bacteria, although they are sometimes termed "blue-green algae" because they resemble **green** algae **in morphology, habitat and photosynthetic ability (and contain chlorophyll).** Some cyanobacteria can produce toxins (cyanotoxins **and endotoxins)** that are harmful to human health. The cell walls of most cyanobacteria contain polysaccharides that may cause skin irritation. Part V contains fact sheets on toxic cyanobacteria and their toxins. Management of cyanobacteria involves: • minimising nutrient inputs into source waters • avoiding water from the surface layer of stratified water bodies • promoting water movement (e.g. through mixing) in unstratified water bodies • treating water to remove cyanobacterial cells and taste and odour compounds and inactivate cyanotoxins. Other pathogens that primarily cause infections of the respiratory system, skin, eyes or other organ systems can be spread via drinking water. In practice the processes for managing enteric pathogen risks will also control these **opportunistic** pathogens if residual disinfection is maintained. These pathogens are discussed further in Section 5.5 and in the corresponding fact sheets in Part V.
5	Visit Chapter 5.3 Assessing microbial risk of the Guidelines	[*unchanged text omitted*] • Risk assessment can be undertaken at different levels of detail and rigour depending on the purpose of the work (e.g. meeting regulatory requirements). This can	[*unchanged text omitted*] • Risk assessment can be undertaken at different levels of detail and rigour depending on the purpose of the work (e.g. meeting regulatory requirements). This can include simple

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	(p76 of PDF)	include simple categorical identification of hazards and risks through to qualitative risk assessment and quantitative microbial risk assessment (QMRA) (Deere and Davison 2005; WHO 2016). **Qualitative risk assessment** rates the risks using categories of likelihood and consequence (see Section 3.2.3). The approach is good for screening large numbers of risks rapidly (as detailed in Element 2 of the Framework, see Section 3.2.3). **- Quantitative Microbial Risk Assessment (QMRA)** involves quantifying each component of the exposure pathway, together with the estimated health outcome. The outcome of a QMRA is a quantitative assessment of risk and is most applicable for answering quantitative questions such as: "What is safe?" and "How much treatment is required to achieve safety?"	categorical identification of hazards and risks through to qualitative risk assessment and quantitative microbial risk assessment (QMRA) (Deere and Davison 2005; WHO 2016). – **Qualitative risk assessment** rates the risks using categories of likelihood and consequence (see Section 3.2.3). The approach is good for screening large numbers of risks rapidly (as detailed in Element 2 of the Framework, see Section 3.2.3). – **Quantitative Microbial Risk Assessment (QMRA)** involves quantifying each component of the exposure pathway, **and combining with dose-response models**, estimating health outcome. The outcome of a QMRA is a quantitative assessment of risk and is most applicable for answering quantitative questions such as: "~~What~~ Is **my system** safe?" and "How much treatment is required to achieve safety?" (**The safety benchmark being 1 µDALY pppy, see Section 5.4.3**).
6	Visit Chapter 5.3 Assessing microbial risk, Figure 5.1 QMRA and epidemiological approaches to characterising risks from drinking water sources of the Guidelines (p77 of PDF)	Figure 5.1 QMRA and epidemiological approaches to characterising risks from drinking water sources [*unchanged text omitted*] • Starting point is pathogen concentration at a defined point • Reduction capacity of drinking water processes • Uses infectivity and health impact data for estimation	Figure 5.1 QMRA and epidemiological approaches to characterising risks from drinking water sources [*unchanged text omitted*] • Starting point is pathogen concentration at a defined point • **Pathogen** reduction capacity of drinking water processes **and barriers** • Uses infectivity and health impact data for estimation

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7	Visit Chapter 5.3 Assessing microbial risk of the Guidelines (p77 of PDF)	[*unchanged text omitted*] Given the limitations of disease surveillance mechanisms to measure endemic disease, an alternative approach is needed to estimate and manage endemic disease burdens to ensure that water is safe. QMRA investigates the likelihood of disease along a risk pathway from the point at which pathogen concentration is quantified (e.g. in a water source) to the receptor (e.g. a consumer of drinking water).	[*unchanged text omitted*] Given the limitations of disease surveillance mechanisms to measure endemic disease, **as for chemical contaminants, quantitative risk assessment is used** to estimate and manage endemic disease burdens to **provide safe** water. QMRA investigates the likelihood of disease along a risk pathway from the point at which pathogen concentration is quantified (e.g. in a water source) to the receptor (e.g. a consumer of drinking water). .....
8	Visit Chapter 5.4 Enteric pathogens, Table 5.1 Enteric pathogens of concern in Australian drinking water of the Guidelines (p79 of PDF)	Table 5.1 Enteric pathogens of concern in Australian drinking water **Group** **Bacteria** *Salmonella* spp. **Viruses** Adenoviruses [*unchanged text omitted*] Enteric hepatitis viruses (hepatitis A) **Protozoa**	Table 5.1 Enteric pathogens of concern in Australian drinking water **Group** **Bacteria** *Salmonella* ***enterica*** **Viruses** **Masta**denoviruses **(human adenoviruses)** [*unchanged text omitted*] Enteric hepatitis viruses (hepatitis A **and E**) **Parasitic** **Protozoa**
9	Visit Chapter 5.4.2 Contamination of source waters with enteric pathogens of the Guidelines	Source water for drinking water supplies is susceptible to contamination with enteric pathogens via faecal material from animals or humans. The extent of contamination depends upon the number of faecal sources and the level of protection of source water catchments.	Source water for drinking water supplies is susceptible to contamination with enteric pathogens via faecal material from animals **and** humans. The extent of contamination depends upon the number of faecal sources and the level of protection of source water catchments.

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	(p79 of PDF)	[*unchanged text omitted*] Animals more likely to carry higher concentrations of pathogens include: • animals living in close proximity to human populations, especially animals most closely associated with humans (e.g. similar gastrointestinal tracts) • more intensively reared and dense animal populations [*unchanged text omitted*] International studies reporting on the environmental monitoring of pathogens in surface waters show that the presence and concentration of enteric pathogens: • [*unchanged text omitted*] • generally reach peak concentrations with increasing human activity in the catchment • increase with increasing average *E. coli* concentrations. A summary of these international studies is provided in Appendix 3. Limited published and extensive unpublished data from Australian systems confirms these trends for a variety of pathogens and faecal indicators, particularly for *Cryptosporidium* spp. oocysts and *E. coli* (Petterson et al. 2015). Groundwater Groundwater sources can become contaminated with enteric pathogens by a range of events	[*unchanged text omitted*] Animals more likely to carry higher concentrations of pathogens include: • animals living in close proximity to human populations, especially animals most closely associated with humans (e.g. pigs, poultry and ruminants) • more intensively reared and dense animal populations [*unchanged text omitted*] International studies reporting on the environmental monitoring of pathogens in surface waters show that the presence and concentration of enteric pathogens: • [*unchanged text omitted*] • generally reach peak concentrations with increasing human activity and during rain events in the catchment • increase with increasing average *E. coli* concentrations. A summary of these international studies is provided in Appendix 3. Limited published and extensive unpublished data from Australian systems confirms these trends for a variety of pathogens and faecal indicators, particularly for *Cryptosporidium* spp. oocysts and *E. coli* (Petterson et al. 2015; Roser and Ashbolt 2007). Groundwater Groundwater sources can become contaminated with enteric pathogens by a range of events including: [*unchanged text omitted*] • wildlife carrying zoonotic pathogens into bores or groundwater

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		including: [*unchanged text omitted*] • wildlife carrying zoonotic pathogens into bores	
10	Visit Chapter 5.4.2 Contamination of source waters with enteric pathogens, Box 5.2 Understanding and managing bore water security of the Guidelines (p80 of PDF)	Box 5.2 Understanding and managing bore water security [*unchanged text omitted*] A precautionary approach should be taken when determining bore water security— multiple waterborne disease outbreaks have arisen where bores were incorrectly assumed to be secure (Hrudey and Hrudey 2004.	Box 5.2 Understanding and managing bore water security [*unchanged text omitted*] A precautionary approach should be taken when determining bore water security— multiple waterborne disease outbreaks have arisen where bores were incorrectly assumed to be secure (Hrudey and Hrudey 2004, 2019).
11	Visit Chapter 5.4.2 Contamination of source waters with enteric pathogens of the Guidelines (p81 of PDF)	Other drinking water sources There are other water sources also used for drinking water or to augment drinking water supplies which are not considered in the context of this chapter. These include: • **Roof water:** Roof-harvested rainwater is typically low risk but is not free from pathogens. Outbreaks of *Salmonella* spp. and *Campylobacter* spp. bacteria have been reported from roof-harvested rainwater within Australia and elsewhere. Information on management of rainwater tanks is provided in *Guidance on the use of rainwater tanks* (enHealth 2010). • **Storm water, greywater and sewage catchments:** Reuse of water drawn from storm water, greywater	Other drinking water sources There are other water sources also used for drinking water or to augment drinking water supplies which are not considered in the context of this chapter. These include: • **Roof water:** Roof-harvested rainwater is typically low risk but is not free from pathogens **(Chubaka et al. 2018).** Outbreaks of *Salmonella* and *Campylobacter* spp. bacteria have been reported from roof-harvested rainwater within Australia and elsewhere. Information on management of rainwater tanks is provided in *Guidance on the use of rainwater tanks* (enHealth 2010). • **Storm water, greywater and sewage catchments:** Reuse of water drawn from storm water, greywater or treated sewage is addressed under the *Australian Guidelines for Water Recycling (Phase 2)*, **which provide health-based targets (NRMMC, EHPC**

No.	Section of Guidelines	Current Guidelines text (V4.0)	Proposed Guidelines text (V4.1)
		or treated sewage is addressed under the *Australian Guidelines for Water Recycling (Phase 2)* (NRMMC, EHPC and NHMRC 2008). • Ocean catchments: [*unchanged text omitted*]	and NHMRC 2008). Recommended approaches to derive LRVs are also provided in US EPA guidance (Jahne et al. 2017, 2025). • Ocean catchments: [*unchanged text omitted*]
12	Visit Chapter 5.4.3 Management of risk from enteric pathogens of the Guidelines (p81 of PDF)	5.4.3 Management of risk from enteric pathogens [*unchanged text omitted*] However, contaminated source waters with inadequate treatment are likely contributors (see section 5.3). [*unchanged text omitted*] Benchmark of safety: Microbial safety and the water safety continuum There is no such thing as zero risk—when quantifying microbial safety within a risk framework it is necessary to define a level that is considered to be tolerable or safe. The definition of microbial safety used in these Guidelines for drinking water is a health outcome target of 1 x 10^{-6} Disability Adjusted Life Years (DALY or 1 µDALY) per person per year (pppy) (as discussed in Appendix 3). It is the same health outcome target adopted by the *Australian Guidelines for Water Recycling* (2006, 2008, 2009, 2018), WHO (2017) and Health Canada (2019). The microbial health outcome target of 1 x 10^{-6} DALY pppy should be applied as an operational benchmark rather than a pass/fail guideline value (Walker 2016). It should not be used as a measure of regulatory compliance. This benchmark serves two important purposes:	5.4.3 Management of risk from enteric pathogens [*unchanged text omitted*] However, contaminated source waters with inadequate treatment are likely contributors (see Section 5.3). [*unchanged text omitted*] Benchmark of safety: Microbial safety and the water safety continuum There is no such thing as zero risk—when quantifying microbial safety within a risk framework it is necessary to define a level that is considered to be tolerable or safe. The definition of microbial safety used in these Guidelines for drinking water is a health outcome target of 1 x 10^{-6} Disability Adjusted Life Years (DALY), equivalent to one in a million per year (1 µDALY pppy) (as discussed in Appendix 3). It is the same health outcome target adopted by the *Australian Guidelines for Water Recycling* (2006, 2008, 2009, 2018), WHO (2017) and Health Canada (2019). The microbial health outcome target of 1 µ DALY pppy should be applied as an operational benchmark rather than a pass/fail guideline value (Walker 2016). It should not be used as a measure of regulatory compliance. This benchmark serves two important purposes: 3. setting a definitive target for defining microbially-safe drinking water 4. informing improvement programs to enhance safety of drinking water as per element 12 of the Framework for Management of

No.	Section of Guidelines	Current Guidelines text (V4.0)	Proposed Guidelines text (V4.1)
		1. setting a definitive target for defining microbially-safe drinking water 2. informing improvement programs to enhance safety of drinking water as per element 12 of the Framework for Management of Drinking Water Quality. Immediate compliance of all drinking water supplies with the health outcome target of 1 x10^{-6} DALY pppy is not expected (see Box 5.1). [*unchanged text omitted*] The greater the shortfall between the estimated risk associated with the water supply and the 1 × 10^{-6} DALY (1 µDALY) pppy target, the more urgent and significant the action required to move the supply towards the benchmark value (Box 5.3).	Drinking Water Quality. Immediate compliance of all drinking water supplies with the health outcome target of 1 µ DALY pppy is not expected (see Box 5.1). [*unchanged text omitted*] The greater the shortfall between the estimated risk associated with the water supply and the ~~1 × 10^{-6} DALY~~ 1 µDALY pppy target, the more urgent and significant the action required to move the supply towards the benchmark value (Box 5.3).
13	Visit Chapter 5.4.3 Management of risk from enteric pathogens, Figure 5.3 The representation of the theoretical decline in the number of cases per 1000 people per year attributed to	Figure 5.3 The representation of the theoretical decline in the number of cases per 1000 people per year attributed to *Cryptosporidium*	Figure 5.3 The representation of the theoretical decline in the number of cases per 1000 people per year attributed to *Cryptosporidium* spp.

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	Cryptosporidium of the Guidelines (p83 of PDF)		
14	Visit Chapter 5.4.3 Management of risk from enteric pathogens, Table 5.2 Vulnerability classes for surface drinking water sources of the Guidelines (p84 of PDF)	Table 5.2 Vulnerability classes for surface drinking water sources Protection measures [*unchanged text omitted*] Low intensity/low risk activities may be allowed in the outer catchment, but active source protection (e.g. ranger surveillance) is practised to ensure negligible contamination risk.	Table 5.2 Vulnerability classes for surface drinking water sources Protection measures [*unchanged text omitted*] Low intensity/low risk activities may be allowed in the outer catchment, but active source protection (e.g. ranger surveillance) is practiced to ensure negligible contamination risk.
15	Visit Chapter 5.4.3 Management of risk from enteric pathogens of the Guidelines (p89 of PDF)	[*unchanged text omitted*] Source water that regularly returns *E. coli* concentrations >20,000 organisms per 100 mL (i.e. above the limit for *E. coli* band 3) should be reconsidered as a suitable source for drinking water supplies. Source water containing such high levels of *E. coli* is likely to be highly contaminated with faecal waste and associated enteric pathogens. [*unchanged text omitted*] The following issues should be considered during *E. coli* monitoring and microbial band allocation: [*unchanged text omitted*] **Minimum required datasets and appropriate selection of maximum *E. coli*:** The suggested minimum monitoring period to characterise microbial risk is two years, which would provide at least 100 data points with weekly	[*unchanged text omitted*] Source water that regularly returns *E. coli* concentrations >20,000 organisms per 100 mL (i.e. above the limit for *E. coli* band 3) should **not** be considered as **generally** suitable for drinking water supplies. S**uch** s**ource waters are** likely to be highly contaminated with faecal waste and associated enteric pathogens. [*unchanged text omitted*] The following issues should be considered during *E. coli* monitoring and microbial band allocation: [*unchanged text omitted*] **Minimum required datasets and appropriate selection of maximum *E. coli*:** The suggested minimum monitoring period to characterise microbial risk is two years, which would provide at least 100 data points with weekly sampling. A longer monitoring period may be needed if no events, such as heavy rainfall, occur or are captured by monitoring during the initial two-year period. Given the wide

No.	Section of Guidelines	Current Guidelines text (V4.0)	Proposed Guidelines text (V4.1)
		sampling. A longer monitoring period may be needed if no events, such as heavy rainfall, occur or are captured by monitoring during the initial two-year period. Given the wide fluctuations that can occur with microbial concentrations in surface water, the peak concentrations should not be disregarded as outliers. The maximum *E. coli* result should be used for the allocation of a microbial band (Walker et al. 2015) unless the data set is robust enough to use the 95th percentile. [*unchanged text omitted*] • **Interim approach in the absence of data**: There may be instances where there is not enough data to confidently allocate a microbial band, but the source water still needs to be categorised. The source water category will need to be based on the vulnerability classification alone until sufficient raw water *E. coli* monitoring is undertaken. A conservative *E. coli* band allocation is recommended while sufficient monitoring data is collected. This may place small water suppliers into the most conservative category due to a lack of data (see Box 5.4). Historical thermotolerant coliform data (which may have previously been referred to as faecal bacteria indicators) may be used in the short term as a substitute for *E. coli* data until sufficient *E. coli* monitoring data is obtained.	fluctuations that can occur with microbial concentrations in surface water, the peak concentrations should not be disregarded as outliers. The maximum *E. coli* result should be used for the allocation of a microbial band (Walker et al. 2015) unless the data set is robust enough **(i.e. > 25 samples for each condition/scenario considered likely)** to use the 95th percentile **(Signor et al. 2007).** [*unchanged text omitted*] **Interim approach in the absence of data**: There may be instances where there is not enough data to confidently allocate a microbial band, but the source water still needs to be categorised. The source water category will need to be based on the vulnerability classification alone until sufficient raw water *E. coli* monitoring is undertaken. A conservative *E. coli* band allocation is recommended while sufficient monitoring data is collected. This may place small water suppliers into the most conservative category due to a lack of data (see Box 5.4). Historical thermotolerant coliform data (which may have previously been referred to as faecal **indicator** bacteria may be used in the short term as a substitute for *E. coli* data until sufficient *E. coli* monitoring data is obtained.
16	Visit Chapter 5.4.3 Management of risk from enteric pathogens, Box 5.5 Environmental *E.*	[*unchanged text omitted*] Simultaneous monitoring for *Enterococci* and *E. coli* may assist in strengthening the evidence of a non-faecal (environmental) source (i.e. low numbers of enterococci as compared with *E. coli*).	[*unchanged text omitted*] Simultaneous monitoring for enterococci and *E. coli* may assist in strengthening the evidence of a non-faecal (environmental) source. Enterococci **are generally an order of magnitude lower than *E. coli* in faecally-contaminated**

No.	Section of Guidelines	Current Guidelines text (V4.0)	Proposed Guidelines text (V4.1)
	coli of the Guidelines (p91 of PDF)	If evidence demonstrates an environmental source of *E. coli* (such as a bloom), then these results may be omitted from the dataset used to set the microbial monitoring band. This should only be done in consultation with the relevant health authority or drinking water regulator. Blooms are very uncommon events—the discounting of results should only be considered when the evidence for their occurrence is clear. Even in the confirmed presence of an environmental *E. coli* bloom, it is likely that *E. coli* that are faecal in origin will also be present at lower concentrations. This could present a health risk. Further details on the management of environmental *E. coli* is available in Sinclair (2019).	source waters (Ashbolt et al. 1997). If evidence demonstrates an environmental source of *E. coli* (such as a bloom), then these results may be omitted from the dataset used to set the microbial monitoring band. This should only be done in consultation with the relevant health authority or drinking water regulator. Blooms are very uncommon events—the discounting of results should only be considered when the evidence for their occurrence is clear. Even in the confirmed presence of an environmental *E. coli* bloom, it is likely that *E. coli* that are faecal in origin will also be present at lower concentrations. This could present a health risk. Further details on environmental *E. coli* is available in Nanayakkara et al. (2019) and Bertone et al. (2019).
17	Visit Chapter 5.4.3 Management of risk from enteric pathogens, Box 5.6 Reservoirs and risk management: Understanding and managing reservoirs for control of pathogen risk (and	Box 5.6 Reservoirs and risk management: Understanding and managing reservoirs for control of pathogen risk (and LRVs) Reservoirs are a valuable barrier for pathogen removal/inactivation and can contribute to the overall treatment target (expressed as LRVs) of a treatment train. When contributing to the LRV, it is essential that the pathogen removal performance of the reservoir be quantitatively evaluated for all relevant conditions. This will involve a site-specific evaluation of the fate and transport of pathogens in the reservoir. Researchers have investigated the way in which pathogens move through reservoirs (Brookes et al. 2004). Some pathogens are settled by gravity if water is	Box 5.6 Reservoirs and risk management: Understanding and managing reservoirs for control of pathogen risk (and LRVs) Reservoirs are a valuable barrier for pathogen removal/inactivation and can contribute to the overall treatment target (expressed as LRVs) of a treatment train. When contributing to the LRV, it is essential that the pathogen removal performance of the reservoir be quantitatively evaluated for all relevant conditions. This will involve a site-specific evaluation of the likely fate and transport of pathogens in the reservoir. Researchers have investigated the way in which pathogens move through reservoirs (Brookes et al. 2004). Some pathogens are settled by gravity if water is static. They may also be inactivated by temperature, sunlight and predation at varying rates. Pathogen

No.	Section of Guidelines	Current Guidelines text (V4.0)	Proposed Guidelines text (V4.1)
	LRVs) of the Guidelines (p92 of PDF)	static. They may also be inactivated by temperature, sunlight and predation at varying rates. Pathogen risk can be reduced if water is stored for long enough. If waters are very clear and shallow, factors such as temperature and sunlight can also influence how much pathogens are reduced. This is particularly the case for organisms which are sensitive to UV light, such as *Cryptosporidium*. Under relatively low flow conditions, reservoirs can provide good removal when pathogen ingress occurs some distance from the offtake. However, in practice reservoir storage barriers can be compromised by: • waterfowl perching on offtake infrastructure • public access, such as recreation close to water supply offtakes • short circuiting through a combination of hydraulic forcing and temperature/density-related buoyancy especially following rain events • resuspension of sediments containing pathogens that are able to survive in the environment following rain-events and rapid inflows into reservoirs. To be confident in the ability of a reservoir to contribute to the LRV (through processes such as dilution, attenuation and settling) the following factors need to be understood: the hydrodynamics of the reservoir	risk can be reduced if water is stored for long enough. If waters are very clear and shallow, factors such as temperature and sunlight can also influence how much pathogens are reduced. This is particularly the case for organisms which are sensitive to UV light, such as enteric bacteria and *Cryptosporidium* oocysts. Under relatively low flow conditions, reservoirs can provide good removal when pathogen ingress occurs some distance from the offtake. However, in practice reservoir storage barriers can be compromised by: • waterfowl perching on offtake infrastructure • public access, such as recreation close to water supply offtakes • short circuiting through a combination of hydraulic forcing and temperature/density- related buoyancy especially following rain events • resuspension of sediments containing pathogens that are able to survive in the environment following rain-events and rapid inflows into reservoirs. To be confident in the ability of a reservoir to contribute to the LRV (through processes such as dilution, attenuation and settling) the following factors need to be understood: • the hydrodynamics of the reservoir, particularly associated with high-volume inflow event periods such as floods or high flow managed releases, and seasonal winter mixing that can disturb and resuspend bottom sediments; and • sources of direct pathogen ingress (e.g. from public access, including recreation if allowed or frequently observed).

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		sources of direct pathogen ingress (e.g. from public access, including recreation if allowed or frequently observed) the dynamics of water inflow (particularly high-volume inflow events such as floods or high flow managed releases). Risk management [*unchanged text omitted*]	Risk management [*unchanged text omitted*]
18	Visit Chapter 5.4.3 Management of risk from enteric pathogens, Box 5.7 Enteric Pathogen data of the Guidelines (p94 of PDF)	[*unchanged text omitted*] • the statistical methods applied to estimate the mean and upper bound concentration are considered alongside the nature of the data. Were the data direct counts, presence/ absence results or categorical most probable numbers (MPNs)? What was the sample volume? Was the sample correct for the recovery (performance) of the method? • the dataset is sufficiently robust to account for the range of conditions that might be experienced. It should cover the range of flood and drought cycles, as well as extreme peak and failure mode events. It may take hundreds of samples and many years to obtain such a robust dataset. Further practical details [*unchanged text omitted*]	[*unchanged text omitted*] • the statistical methods applied to estimate the mean and upper bound concentration are considered alongside the nature of the data **and catchment conditions**. Were the data direct counts, presence/ absence results or categorical most probable numbers (MPNs)? What was the sample volume? Was the sample correct for the recovery (performance) of the method? • the dataset is sufficiently robust to account for the range of conditions that might be experienced. It should cover the range of flood and drought cycles, as well as extreme peak and failure mode events. It may take hundreds of samples and many years to obtain such a robust dataset**, and it is useful to characterise event conditions separately from those representing nominal/routine operating conditions when reviewing Table 5.5 (see Signor et al. 2005).** Further practical details [*unchanged text omitted*]
19	Visit Chapter 5.4.3 Management of risk from enteric	*Meeting the treatment requirements* The treatment target is expressed as a single required LRV for each pathogen group. The total log_{10} reduction	*Meeting the treatment requirements* The treatment target is expressed as a single required LRV for each pathogen group. The total log_{10} reduction (calculated by summing

No.	Section of Guidelines	Current Guidelines text (V4.0)	Proposed Guidelines text (V4.1)
	pathogens of the Guidelines (p94 of PDF)	(calculated by summing the log_{10} reduction credits of individual treatment or environmental barriers) must meet or exceed the LRV required in Table 5.5. This does not [*unchanged text omitted*]	the log_{10} reduction credits of individual treatment or environmental barriers) must meet or exceed the LRV required in Table 5.5 **for nominal and event conditions**. This does not [*unchanged text omitted*]
20	Visit Chapter 5.4.3 Management of risk from enteric pathogens, Table 5.6 **Indicative pathogen LRV potentially attributable to treatment barriers** of the Guidelines (p95 of PDF)	See Appendix A for current Table 5.6 *Footnotes under Table 5.6:* 1 LRVs can only be claimed if meeting requirements described in published material or by certification against validation protocols (as cited for individual processes) (see Chapter 9 and Victorian Department of Health 2013). 2 USEPA 2006 (also see Turbidity Fact Sheet). 3 USEPA 2005. 4 Keegan et al. 2012 (see Information Sheet 1.3 "Disinfection with Chlorine"); WaterVal 2017a. 5 Concentration (C) and the corresponding disinfectant contact time (t) in minutes (C.t). 6 Keegan et al. 2012 (see Information Sheet 1.4 "Chloramines"). 7 (see Information Sheet 1.7 "Disinfection with Ultraviolet Light"); WaterVal 2017b. 8 (see Information Sheet 1.6 "Disinfection with Ozone"); Waterval 2017c. 9 Waterval 2017d.	See Appendix A for Table 5.6 proposed amendments *Footnotes under Table 5.6:* 1 **The data presented in this table for disinfectants assumes pathogens are freely suspended. If pathogens are contained within aggregates of other matter, including free-living protozoa commonly found in water systems, then for the fraction of internalised pathogens, the inactivation credits may need to be reduced by at least 2 logs (Folkins et al. 2020).** LRVs can only be claimed if meeting requirements described in published material or by certification against validation protocols (as cited for individual processes) (see Chapter 9 and Victorian Department of Health 2013) **2** US EPA 2005. **3** Keegan et al. 2012 (see Information Sheet 1.3 "Disinfection with Chlorine"); WaterVal 2017a. **4** Concentration (C) and the corresponding disinfectant contact time (t) in minutes (C.t). **5** Keegan et al. 2012 (see Information Sheet 1.4 "Chloramines").

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			6 (see Information Sheet 1.5 "Disinfection with chlorine dioxide") 7 (see Information Sheet 1.7 "Disinfection with Ultraviolet Light"); WaterVal 2017b. 8 (see Information Sheet 1.6 "Disinfection with Ozone"); Waterval 2017c. 9 Waterval 2017d.
21	Visit Chapter 5.4.3 Management of risk from enteric pathogens of the Guidelines (page 97 of PDF)	Management of the distribution network Waterborne disease outbreaks can occur due to post treatment contamination. Health-based targets were introduced in the US in 1996. Around 90% of outbreaks since then are attributed to contamination within the distribution system. Treated drinking water can become re-contaminated with [*unchanged text omitted*]	Management of the distribution network Waterborne disease outbreaks can occur due to post treatment contamination. Health-based targets were introduced in the US in 1996. Around 90% of outbreaks since then are attributed to contamination within the distribution system or opportunistic pathogens within premises (Beer et al. 2015; Benedict et al. 2017). Treated drinking water can become re-contaminated with [*unchanged text omitted*]
22	Visit Chapter 5.5 Opportunistic pathogens of the Guidelines (p98 of PDF)	Opportunistic pathogens of concern in drinking water are summarised in Table 5.7. *Naegleria fowleri, Burkholderia pseudomallei* and *Legionella pneumophila* are particularly significant.	The most common opportunistic pathogens of concern in drinking water are summarised in Table 5.7. *Naegleria fowleri*, *Burkholderia pseudomallei* and *Legionella pneumophila* are particularly significant.
23	Visit Chapter 5.5 Opportunistic pathogens, Table 5.7 Opportunistic pathogens of concern in Australian	See Appendix B for Table 5.7 Opportunistic pathogens of concern in Australian drinking water	See Appendix B for proposed amendments to Table 5.7

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	drinking water of the Guidelines (p98 of PDF)		
24	Visit Chapter 5.5 Opportunistic pathogens of the Guidelines (p98 of PDF)	Specifying a health-based target for opportunistic pathogens is not practicable. Management of opportunistic pathogens relies on the four following aspects: • **Assessment of source water contamination**: Opportunistic pathogens are naturally occurring environmental microorganisms. They should be assumed to be present in source waters when the conditions (e.g. temperature) are consistent with the pathogen ecology (see the relevant Fact Sheets in Part V). For example, organisms such as *Naegleria fowleri* and *Burkholderia pseudomallei* are typically only present in warmer waters >25°C continuously or >30°C seasonally as they are thermophilic. **Drinking water treatment: [*unchanged text omitted*]** • **Distribution network management:** Opportunistic pathogens can grow in drinking water distribution systems (Storey and Kaucner 2009), depending on temperature, hydraulic demand, disinfectant type and concentration. Growth of **[*unchanged text omitted*]** • **Management of in-premise plumbing systems**: Plumbing systems can create conditions	Specifying a health-based target for opportunistic pathogens is not practicable. Management of opportunistic pathogens relies on the four following aspects: • **Assessment of source water contamination**: Opportunistic pathogens are naturally occurring environmental microorganisms. They should be assumed to be present in source waters when the conditions (e.g. temperature) are consistent with their ecology (see the relevant Fact Sheets in Part V). For example, organisms such as *Naegleria fowleri* and *Burkholderia pseudomallei* are typically only present in warmer waters >25°C continuously or >30°C seasonally as they are thermophilic. • **Drinking water treatment: [*unchanged text omitted*]** • **Distribution network management:** Opportunistic pathogens can grow in drinking water distribution systems **(Storey et al. 2008;** Storey and Kaucner 2009; **Whiley et al. 2014**), depending on temperature, hydraulic demand, disinfectant type and concentration. Growth of **[*unchanged text omitted*]** • **Management of in-premise plumbing systems**: Plumbing systems can create conditions **that support the growth of various** opportunistic pathogens (in particular *Legionella pneumophila*). Plumbing systems should be designed and managed to avoid warm water (keep stored cold water cold at <20°C and stored hot water at >60°C **and 50°C > at distal parts)** (WHO 2011c; enHealth 2015, WHO 2017**; NAS**

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		conducive to opportunistic pathogen (in particular *Legionella)* growth. Plumbing systems should be designed and managed to avoid warm water (keep stored cold water cold at <20^{O}C and stored hot water at >60^{O}C (WHO 2011c; enHealth 2015, WHO 2017) and avoid stagnation. Detailed guidance on managing the risks is given in the *Guidelines for Legionella Control in the operation and maintenance of water distribution systems in health and aged care facilities* (enHealth 2015).	2020) and avoid stagnation. Detailed guidance on managing the risks is given in the *Guidelines for Legionella Control in the operation and maintenance of water distribution systems in health and aged care facilities* (enHealth 2015).
25	Visit Chapter 5.7 Nuisance organisms of the Guidelines (p100 of PDF)	Nuisance organisms in drinking water are those that are not pathogenic but can cause aesthetic issues and corrosion of the distribution network (AWWA 2014). Nuisance organisms comprise a morphologically and physiologically diverse collection of organisms. They include: • bacteria such as non-toxic planktonic and benthic cyanobacteria (commonly known as blue-green algae) • iron, manganese and sulfur reducing bacteria • anaerobic (actinomycete) bacteria and fungi • eukaryotic organisms (organisms with cells containing a nucleus) such as true algae, crustacea and protozoa. Problems occur when the conditions in source waters, reservoirs or distribution systems support the growth of	Nuisance organisms in drinking water are those that are not pathogenic but can cause aesthetic issues and corrosion of the distribution network (AWWA 2014). Nuisance organisms comprise a morphologically and physiologically diverse collection of organisms. They include: • bacteria such as non-toxic planktonic and benthic cyanobacteria (commonly known as blue-green algae) • iron, manganese and sulfur reducing bacteria • actinomycete (bacteria) and fungi • eukaryotic organisms (organisms with cells containing a nucleus) such as true algae, crustacea and protozoa. Problems occur when the conditions in source waters, reservoirs or distribution systems support the growth of a particular nuisance organism or group of nuisance organisms. For example, excessive quantities of organic matter will support the growth of bacteria, fungi and maintain populations of free-living protozoa (e.g. *Acanthamoeba, Vermamoeba* spp.) and crustacea (e.g. amphipods and copepods).

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		a particular nuisance organism or group of nuisance organisms. For example, excessive quantities of organic matter will support the growth of bacteria, fungi and maintain populations of protozoa (e.g. *Acanthamoebae*) and crustacea (e.g. amphipods and copepods). Many invertebrate animals can feed on bacteria, fungi and protozoa.	Many invertebrate animals can feed on bacteria, fungi and protozoa.

No.	Section of Guidelines	Proposed edits to Chapter 5 Reference List
26	Visit Chapter 5.8 References of the Guidelines (page 102 – 105 of PDF)	**5.8 References** Ashbolt NJ, Dorsch MR, Cox PT, Banens B (1997). Coliforms and E. coli – Problem or Solution? In: Kay D, Fricker C (eds), The Royal Society of Chemistry, Cambridge, pp. 78–85. Ashbolt NJ (2015a). Microbial contamination of drinking water and human health from community water systems. *Current Environmental Health Reports* 2:95–106. Ashbolt NJ (2015b). Environmental (saprozoic) pathogens of engineered water systems: Understanding their ecology for risk assessment and management. *Pathogens* 4:390–405. AWWA (American Water Works Association) (2014). Problem Organisms in Water: Identification and Treatment, 3rd ed. American Water Works Association. Denver, United States of America. Beer KD, Gargano JW, Roberts VA, Hill VR, Garrison LE, Kutty PK, Hilborn ED, Wade TJ, Fullerton KE, Yoder JS (2015). Surveillance for waterborne disease outbreaks associated with drinking water – United States, 2011–2012. *MMWR. Morbidity and Mortality Weekly Report* 64:842–848.

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		Bellini NK, Thiemann OH, Reyes-Batlle M, Lorenzo-Morales J, Costa AO (2022). A history of over 40 years of potentially pathogenic free-living amoeba studies in Brazil – a systematic review. *Memórias do Instituto Oswaldo Cruz* 117:e210373. Benedict KM, Reses H, Vigar M, Roth DM, Roberts VA, Mattioli M, Cooley LA, Hilborn ED, Wade TJ, Fullerton KE, Yoder JS, Hill VR (2017). Surveillance for waterborne disease outbreaks associated with drinking water — United States, 2013–2014. *Morbidity & Mortality Weekly Report* 66:1216–1221. Bertone E, Kozak S, Roiko A (2019). Understanding and modeling the occurrence of E. coli Blooms in drinking water reservoirs. *Water Resources Research* 55(12):10518–10526. doi:10.1029/2019WR025736. Brookes JD, Antenucci J, Hipsey M, Burch MD, Ashbolt NJ, Ferguson C (2004). Fate and transport of pathogens in lakes and reservoirs. *Environment International* 30 (5): 741-759. Chorus I, Welker M, eds. (2021). Toxic Cyanobacteria in Water, 2nd edition. CRC Press, Boca Raton (Florida), on behalf of the World Health Organization, Geneva, Switzerland. Chubaka CE, Whiley H, Edwards JW, Ross KE (2018). Microbiological values of rainwater harvested in Adelaide. *Pathogens* 7(1):21. Dale K, Kirk M, Sinclair M, Hall R, Leder K (2010). Reported waterborne outbreaks of gastrointestinal disease in Australia are predominantly associated with recreational exposure. *Australian and New Zealand Journal of Public Health* 34(5): 527-530. Deere D and Davison A (2005). The Ps and Qs of risk assessment. *Water*, 32(2): 84-93. Deere D and Mosse P (2016). Practical guide to the operation and optimisation of distribution systems, 3rd ed. Water Industry Operators Association of Australia. Shepparton, Australia. Deere D, Petterson S, Roser D, Ryan U, Monis P, O'Connor N, White P, Sinclair M, Canning A (2014). Treatment requirements for Australian source waters to meet health-based targets. Water Research Australia. De Toni PSA and Reilly K (2011). A review of fungi in drinking water and the implications for human health. Department for Environment Food and Rural Affairs, London, United Kingdom. Available at https://www.sheffield.ac.uk/media/7170/download. Environmental Health Standing Committee (enHealth) (2010). Guidance on the use of rainwater tanks. Environmental Health Committee (enHealth) of the Australian Health Protection Committee, Canberra. ISBN 978-1-74241-325-9. Environmental Health Standing Committee (enHealth) (2015). Guidelines for Legionella Control in the operation and maintenance of water distribution systems in health and aged care facilities. Australian Government, Canberra, ISBN: 978-1-76007-271-1.

No.	Section of Guidelines	Proposed edits to Chapter 5 Reference List
		Folkins MA, Dey R, Ashbolt NJ (2020). Interactions between human reovirus and free-living amoebae: Implications for enteric virus disinfection and aquatic persistence. *ACS ES&T* 54(16):10201–10206. Frost FJ, Craun GF, Calderon RL (1996). Waterborne disease surveillance, *Journal of the American Water Works Association* 88(9) 66-75. Gaget V, Humpage AR, Huang Q, Monis P, Brookes JD (2017). Benthic cyanobacteria: A source of cylindrospermopsin and microcystin in Australian drinking water reservoirs. *Water Research.* 124: 454-464. Garner E, Organiscak M, Dieter L, Shingleton C, Haddix M, Joshi S, Pruden A, Ashbolt NJ, Medema G, Hamilton KA (2021). Towards risk assessment for antibiotic resistant pathogens in recycled water: a systematic review and summary of research needs. *Environmental Microbiology* 23:7355–7372. Ghosh R, Leon-Ruiz M, Dubey S, Benito-Leon J (2025). Naegleria fowleri in Kerala, India: prevention over panic. *Lancet* 406(10514):1945. Gibney KB, O'Toole J, Sinclair M, Leder K (2014). Disease burden of selected gastrointestinal pathogens in Australia, 2010. *International Journal of Infectious Diseases*. 28: 176-185. Hayward C, Ross KE, Brown MH, Bentham R, Nisar MA, Hinds J, Xi J, Whiley H (2025). Microbial risks in drinking water systems: persistence and public health implications of opportunistic premise plumbing pathogens. *Frontiers in Microbiology* 16:1575789. Health Canada (2019). Guidelines for Canadian Drinking Water Quality: Guideline Technical Document — Enteric Protozoa: *Giardia* and *Cryptosporidium*. Water and Air Quality Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Canada. (Catalogue No. H144-13/10-2018E-PDF). Hijnen WAM, Beerendonk EF, Medema GJ (2006). Inactivation credit of UV radiation for viruses, bacteria and protozoan (oo)cysts in water: A review. *Water Research* 40: 3-22. Hrudey SE and Hrudey EJ (2004). Safe drinking water: Lessons from recent outbreaks in affluent nations. *IWA publishing,* London, United Kingdom. Hrudey SE, Hrudey EJ (2019). Common themes contributing to recent drinking water disease outbreaks in affluent nations. *Water Supply* 19:1767–1777. Jahne MA, Schoen ME, Garland JL, Ashbolt NJ (2017). Simulation of enteric pathogen concentrations in locally-collected greywater and wastewater for microbial risk assessments. *Microbial Risk Analysis* 5:44–52.

No.	Section of Guidelines	Proposed edits to Chapter 5 Reference List
		Jahne M, Nappier S, Garland J, Schoen M, Soller J (2025). Risk-Based Framework for Developing Microbial Treatment Targets for Water Reuse. EPA/600/R-25/009, Washington, DC, U.S. Environmental Protection Agency. Keegan A, Wati S, Robinson B (2012). Chlor(am)ine disinfection of human pathogenic viruses in recycled waters. Smart Water Fund Project SWF62M-2114, Smart Water Fund, Melbourne, Australia. Kirmeyer GJ (2000). Guidance manual for maintaining distribution system water quality, American Water Works Association. Denver, United States of America. ~~LeChevallier MW, Au K-K (2004). Water treatment and pathogen control. World Health Organization, Geneva, Switzerland.~~ LeChevallier MW, Prosser T, Stevens M (2024). Opportunistic pathogens in drinking water distribution systems – A review. *Microorganisms* 12(5):916.Martel K, Kirmeyer G, Hanson A, Stevens M, Mullenger J, Deere D (2006). Application of HACCP for distribution system protection, American Water Works Association. Denver, United States of America. Miller HC, Morgan MJ, Walsh T, Wylie JT, Kaksonen AH, Puzon GJ (2018). Preferential feeding in Naegleria fowleri; intracellular bacteria isolated from amoebae in operational drinking water distribution systems. *Water Research* 141:126–134. Nanayakkara BS, O'Brien CL, Gordon DM (2019). Diversity and distribution of Klebsiella capsules in Escherichia coli. *Environmental Microbiology Reports* 11:107–117. Nisar MA, Ross KE, Brown MH, Bentham R, Hinds J, Whiley H (2022). Molecular screening and characterization of Legionella pneumophila associated free-living amoebae in domestic and hospital water systems. *Water Research* 226:119238. NRMMC (National Resource Management Ministerial Council), EPHC (Environment Protection and Heritage Council) and AHMC (Australian Health Ministers' Conference) (2006). Australian Guidelines for Water Recycling: Managing health and environmental risks (Phase 1). *Note that this publication is under revision by the Environmental Health Standing Committee (enHealth).* NRMMC (National Resource Management Ministerial Council), EPHC (Environment Protection and Heritage Council) and NHMRC (National Health and Medical Research Council) (2008). Australian Guidelines for Water Recycling: Augmentation of Drinking Water Supplies (Phase 2). Australian Government, Canberra. Petterson S, Roser D, Deere D (2015). Characterizing the concentration of *Cryptosporidium* in Australian surface waters for setting health-based targets for drinking water treatment. *Journal of water and health* 13(3): 879-896. Proctor C, Garner E, Hamilton KA, Ashbolt NJ, Caverly LJ, Falkinham III JO, Haas CN, Prevost M, Prevots DR, Pruden A, Raskin L

No.	Section of Guidelines	Proposed edits to Chapter 5 Reference List
		(2022). Tenets of a holistic approach to drinking water-associated pathogen research, management, and communication. *Water Research* 211:117997. Regli S, Rose JB, Haas CN, Gerba CP (1991). Modeling the risk from *Giardia* and viruses in drinking water. *Journal of American Water Works Association* 83(11): 76-84. Roser DJ, Ashbolt NJ (2007). Source Water Quality Assessment and the Management of Pathogens in Surface Catchments and Aquifers. Research Report 29. CRC for Water Quality and Treatment, Salisbury, SA. Sammon NB, Harrower KM, Fabbro LD, Reed RH (2010). Incidence and Distribution of Microfungi in a Treated Municipal Water Supply System in Sub-Tropical Australia. *International Journal of Environmental Research and Public Health* 7(4):1597–1611. https://doi.org/10.3390/ijerph7041597 Sammon NB, Harrower KM, Fabbro LD, Reed RH (2011). Three Potential Sources of Microfungi in a Treated Municipal Water Supply System in Sub-Tropical Australia. *International Journal of Environmental Research and Public Health* 8(3):713–732. https://doi.org/10.3390/ijerph8030713 Signor RS, Roser DJ, Ashbolt NJ, Ball JE (2005). Quantifying the impact of runoff events on microbiological contaminant concentrations entering surface drinking source waters. *Journal of Water and Health* 3:453–468. Signor RS, Ashbolt NJ, Roser DJ (2007). Microbial risk implications of rainfall-induced runoff events entering a reservoir used as a drinking-water source. *Journal of Water Supply: Research and Technology AQUA* 56(8):515–531. Sinclair M (2019). Discussion Report: Identification and management of environmental *E. coli* Blooms, Water RA Project #1101, Water Research Australia Limited. Storey MV, Kaucner C (2009). Understanding the growth of opportunistic pathogens in distribution systems. Adelaide, Water Quality Research Australia. ISBN: 9781876616298. Storey MV, Kaucner CE, Angles ML, Blackbeard JR, Ashbolt NJ (2008). Opportunistic pathogens in drinking and recycled water distribution systems. *Water* (Australian Water Association) 35:38–45. Thomas V, McDonnell G, Denyer SP, Maillard J-Y (2010). Free-living amoebae and their intracellular pathogenic microorganisms: risks for water quality. *FEMS Microbiology Reviews* 34(3):231–259. https://doi.org/10.1111/j.1574-6976.2009.00190.x United States Environmental Protection Agency (USEPA) (1999). Alternative disinfectants and oxidants guidance manual. Washington DC, United States of America.

No.	Section of Guidelines	Proposed edits to Chapter 5 Reference List
		United States Environmental Protection Agency (USEPA) (2005). Membrane Filtration Guidance Manual. EPA 815-R-06-009. Washington DC, United States of America. United States Environmental Protection Agency (USEPA) (2010). Long term 2 enhanced surface water treatment rule toolbox guidance manual. Washington DC, United States of America. United States Environmental Protection Agency (USEPA) (2006). National Primary Drinking Water Regulations: Long Term 2 Enhanced Surface Water Treatment Rule; Final Rule. Federal Register, 71:3:653, 5 January 2006. Washington DC, United States of America. Victorian Department of Health (2013). Guidelines for validating treatment processes for pathogen reduction: Supporting Class A recycled water schemes in Victoria, State Government of Victoria, Australia. Walker E, Canning A, Angles M, Ball A, Stevens M, Ryan G, Liston C, Deere D (2015). Semi Quantitative Assessment of Microbial Source Risk. Australian Experience from Pilots of Implementing a Health Based Target for Microbial Water Quality, Occasional Paper, Water Research Australia. Walker R (2016). The water safety continuum: A practical way to implement a health-based target for microbial water quality, *Water e-Journal* 1(1). Wan Q, Wen G, Cui Y (2023). Occurrence and control of fungi in water: New challenges in biological risk and safety assurance. *Science of the Total Environment* 860:160536. Water Research Australia (2015). Good practice guide to the operation of drinking water supply systems for the management of microbial risk. Final Report Project 1074, Water Research Australia Limited. Water Research Australia (2021). Good Practice Guide to Sanitary Surveys and Operational Monitoring to Support the Management of Drinking Water Catchments. Final Report Project 1109, Water Research Australia Limited. *Please note that project reports are currently only available to WaterRA members.* ~~Water Services Association of Australia (WSAA) (2015). Manual for the application of health-based targets for drinking water safety. Water Services Association of Australia, ISBN 1 920760 68 7~~ WaterVal (2017a). WaterVal Chlorine disinfection Validation protocol. Australian Watersecure Innovations Ltd 2017. WaterVal (2017b). WaterVal Ultraviolet disinfection: Guidance document. Australian Watersecure Innovations Ltd 2017. Waterval (2017c). WaterVal Ozone disinfection: Validation protocol. Australian Watersecure Innovations Ltd 2017.

No.	Section of Guidelines	Proposed edits to Chapter 5 Reference List
		Waterval (2017d). WaterVal Reverse Osmosis and nanofiltration: Validation protocol. Australian Watersecure Innovations Ltd 2017. Whiley H, Keegan A, Fallowfield H, Bentham R (2014). Detection of Legionella, L. pneumophila and Mycobacterium avium complex (MAC) along potable water distribution pipelines. *International Journal of Environmental Research and Public Health* 11(7):7393–7405. World Health Organization (WHO) (1996). *Guidelines for drinking-water quality*, second edition. Geneva, Switzerland. World Health Organization (WHO) (2011a). Guidelines for drinking-water quality. World Health Organization. Geneva, Switzerland. 216: 303-304. World Health Organization (WHO) (2011b). Safe Drinking-water from Desalination, World Health Organization. Geneva, Switzerland. World Health Organization (WHO) (2011c). Water safety in buildings. World Health Organization. Geneva, Switzerland. World Health Organization (WHO) (2014). Water Safety in Distribution Systems. World Health Organization. Geneva, Switzerland. World Health Organization (WHO) (2016). Quantitative Microbial Risk Assessment for Water Safety Management. Geneva, World Health Organization, Geneva, Switzerland. World Health Organization (WHO) (2016). Protecting surface water for health. Identifying, assessing and managing drinking-water quality risks in surface-water catchments. Edited by Rickert B, Chorus I, Schmoll O. ISBN 978 92 4 151055. World Health Organization. Geneva, Switzerland. World Health Organization (WHO) (2017). Guidelines for drinking-water quality, 4th edition, incorporating the 1st addendum. World Health Organization, Geneva, Switzerland. Zhao HX, Zhang TY, Wang H, Hu CY, Tang YL, Xu B (2022). Occurrence of fungal spores in drinking water: A review of pathogenicity, odor, chlorine resistance and control strategies. *Science of the Total Environment* 853:158626.

Australian Government
National Health and Medical Research Council

NHMRC

Table 2: Proposed amendments to Appendix 3 – Derivation of microbial treatment targets for enteric pathogens

No.	Section of Guidelines	Current Guidelines text (Version 4.0)	Proposed Guidelines text (Version 4.1)
1	Visit A3.5 Selection of reference pathogens of the Guidelines **(p1205 in PDF)**	The calculation of LRVs cannot reasonably be undertaken for all enteric pathogens in drinking water. Reference pathogens (for protozoa, bacteria and viruses) are selected as a conservative model for the group of microorganisms that they represent. If the drinking water is protected from the reference pathogen, then it is assumed that the drinking water is protected from all pathogens in that group.	The calculation of LRVs cannot reasonably be undertaken for all enteric pathogens in drinking water. Reference pathogens (for **parasitic** protozoa, bacteria and viruses) are selected as a conservative model **and geographically representative** for the group of microorganisms that they represent. If the drinking water is protected from the reference pathogen, then it is assumed that the drinking water is protected from all pathogens in that group.
2	Visit A3.5 Selection of reference pathogens, Table A3.1 Case numbers and mortality for selected pathogens causing acute gastroenteritis of the Guidelines **(p1205 in PDF)**	*[First column, first row]* Pathogen	*[First column, first row]* Pathogen **group**
3	Visit A3.5 Selection of reference pathogens of the Guidelines **(p1205 in PDF)**	[*unchanged text omitted*] Of the drinking water outbreaks implicated pathogens were found on all but one occasion. These included *Salmonella* (five outbreaks), *Campylobacter jejuni* (three outbreaks) and *Giardia* (one outbreak). Of the 42 outbreaks attributed to recreational water, all except one were reported to be due to *Cryptosporidium* contamination of swimming pools.	[*unchanged text omitted*] Of the drinking water outbreaks implicated pathogens were found on all but one occasion. These included *Salmonella* ***enterica*** (five outbreaks), *Campylobacter jejuni* (three outbreaks) and *Giardia* (one outbreak). Of the 42 outbreaks attributed to recreational water, all except one were reported to be due to *Cryptosporidium* contamination of swimming pools. **Parasitic protozoa**

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No.	Section of Guidelines	Current Guidelines text (Version 4.0)	Proposed Guidelines text (Version 4.1)
		Protozoa *Cryptosporidium* has been selected as the reference protozoan due to its resistance to chlorine disinfection, high infectivity and the relatively large amount of data available for characterisation. [*unchanged text omitted*] **Bacteria** *Campylobacter* has been selected as the reference bacterial pathogen. The selection of *Campylobacter* is a more conservative option than other candidate bacteria since it is significantly more infectious. [*unchanged text omitted*] **Virus** The reference virus is a combination of culture-based enumeration data for adenovirus and dose-response and health impact data for norovirus.	*Cryptosporidium* ***hominis*** has been selected as the reference protozoan due to its resistance to chlorine disinfection, high infectivity and the relatively large amount of data available for characterisation. [*unchanged text omitted*] **Bacteria** *Campylobacter* ***jejuni*** has been selected as the reference bacterial pathogen. The selection of *Campylobacter* is a more conservative option than other candidate bacteria since it is significantly more infectious. [*unchanged text omitted*] **Virus** The reference virus is a combination of culture-based enumeration data for human adenovirus**es** and dose-response and health impact data for Norovirus.
4	Visit A3.6 Level of reference pathogen contamination in Australian source waters, Table A3.2 Summary of the range of reported concentrations of reference pathogens in surface water of the Guidelines	*[First column, third row]* *Campylobacter* *[First column, fourth row]* *Salmonella* *[First column, sixth row]* Adenovirus[3] *[First column, seventh row]*	*[First column, first row]* *Campylobacter* ***jejuni*** *[First column, second row]* *Salmonella* ***enterica*** *[First column, sixth row]* Human adenovirus[3] *[First column, seventh row]*

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No.	Section of Guidelines	Current Guidelines text (Version 4.0)	Proposed Guidelines text (Version 4.1)
	(p1206 in PDF)	Noroviruses *[First column, ninth row]* **Protozoa**	Noroviruses[3] *[First column, ninth row]* **Parasitic protozoa**
5	Visit A3.6 Level of reference pathogen contamination in Australian source waters of the Guidelines **(p1207 in PDF)**	[***unchanged text omitted***] Other than for *Cryptosporidium* it is very difficult to make inferences about the pathogen concentration in source waters without local environmental Australian datasets. WHO has recommended assuming that the source water is contaminated with a certain percentage of wastewater as a starting point for estimating the LRV needed to address pathogen risks from a catchment (WHO 2011). The adenovirus (by culture) and *Campylobacter* concentrations expected for each catchment category were estimated by applying this principle and using *E. coli* as a surrogate to quantify the amount of raw sewage present in the source water. Point estimates (to one significant figure) of *E. coli*, Adenovirus (by culture) and *Campylobacter* in untreated sewage were calculated from reported concentrations in confidential Australian datasets reviewed by the *Australian Guidelines for Water Recycling* working committee while reviewing the 2006 *Australian Guidelines for Water Recycling* (NRMMC, EHPC and AHPC 2006).	[***unchanged text omitted***] Other than for *Cryptosporidium*, it is very difficult to make inferences about the pathogen concentration in source waters without local environmental Australian datasets. WHO has recommended assuming that the source water is contaminated with a certain percentage of wastewater as a starting point for estimating the LRV needed to address pathogen risks from a catchment (WHO 2011). The human adenovirus**es** (by culture) and ***C. jejuni*** concentrations expected for each catchment category were estimated by applying this principle and using *E. coli* as a surrogate to quantify the amount of raw sewage present in the source water. Point estimates (to one significant figure) of *E. coli*, human adenovirus**es** (by culture) and ***C. jejuni*** in untreated sewage were calculated from reported concentrations in confidential Australian datasets reviewed by the *Australian Guidelines for Water Recycling* working committee while reviewing the 2006 *Australian Guidelines for Water Recycling* (NRMMC, EHPC and AHPC 2006).
6	Visit A3.6 Level of reference pathogen contamination in Australian source waters, Table A3.3 Point	Table A3.3 Point estimates of E. coli, Adenovirus (by culture) and Campylobacter in untreated sewage *[First column, third row]* *Cryptosporidium*	Table A3.3 Point estimates of *E. coli*, ***Cryptosporidium,*** human adenovirus**es** (by culture) and *C. **jejuni*** in untreated sewage *[First column, third row]* *Cryptosporidium* spp.

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No.	Section of Guidelines	Current Guidelines text (Version 4.0)	Proposed Guidelines text (Version 4.1)
	estimates of *E. coli*, Adenovirus (by culture) and *Campylobacter* in untreated sewage of the Guidelines **(p1207 in PDF)**	(infectious oocysts/L) *[First column, fourth row]* Adenovirus (MPNIU/L) *[First column, fifth row]* *Campylobacter* (MPN/L)	(infectious oocysts/L) *[First column, fourth row]* Human adenoviruses (MPNIU/L) *[First column, fifth row]* *Campylobacter* spp. (MPN/L)
7	Visit A3.6 Level of reference pathogen contamination in Australian source waters of the Guidelines **(p1208 in PDF)**	[*unchanged text omitted*] For example, if a catchment has been determined as Class 2 through the vulnerability classification, then the typical adenovirus concentration should be assumed to be 0.16 MPNIU/L and the typical *Campylobacter* concentration should be assumed to be 0.14 MPN/L. Variations to this approach should be discussed with the relevant health authority or drinking water regulator.	[*unchanged text omitted*] For example, if a catchment has been determined as Class 2 through the vulnerability classification, then the typical **human** adenovirus concentration should be assumed to be 0.16 MPNIU/L and the typical *Campylobacter* **spp.** concentration should be assumed to be 0.14 MPN/L. Variations to this approach should be discussed with the relevant health authority or drinking water regulator.
8	Visit A3.8 Dose response relationships, Table A3.5 Summary of dose-response models that could be used for calculation of LRVs of the Guidelines **(p1209 in PDF)**	*[First column, second row]* *Campylobacter* (cfu) *[First column, fourth row]* *Cryptosporidium* (oocysts)	*[First column, second row]* *C. jejuni* (cfu) *[First column, fourth row]* *Cryptosporidium parvum* (oocysts)
9	Visit A3.9 Disability Adjusted Life Years	[*unchanged text omitted*] DALY/case estimates incorporate the contribution of the long-term consequences of acute gastroenteritis for	[*unchanged text omitted*] DALY/case estimates incorporate the contribution of the long-term consequences of acute gastroenteritis for *Campylobacter*

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No.	Section of Guidelines	Current Guidelines text (Version 4.0)	Proposed Guidelines text (Version 4.1)
	(DALY) burden per case of the Guidelines **(p1210 in PDF)**	*Campylobacter* (Guillain–Barré syndrome, reactive arthritis, irritable bowel syndrome) and *Salmonella* (reactive arthritis, irritable bowel syndrome).	***jejuni*** (Guillain–Barré syndrome, reactive arthritis, irritable bowel syndrome) and *Salmonella* (reactive arthritis, irritable bowel syndrome).
10	Visit A3.11 Interpretation of calculated LRVs for practical treatment guidance, Table A3.9 Recommended LRVs by source water category (also see Chapter 5 Table 5.5) of the Guidelines **(p1213 in PDF)**	*[Fourth column, first row]* LRV target to achieve 1 µDALY per person per year - Protozoa(2) (3) The LRV was based on the ratio between protozoa concentration and the adenovirus concentration (MPNIU/L) found in sewage (viruses being present at approximately 0.5 log higher concentrations than protozoa as shown in Table A3.3). For Category 1 sources which have no humans in the catchment a 0 log reduction is set as humans are the predominant source of enteric viruses. (4) The LRV was based on the ratio between protozoa and bacteria found in sewage (bacteria being present at approximately 0.5 log higher concentrations than protozoa as shown in Table A3.3) for Category 4 sources.	*[Fourth column, first row]* LRV target to achieve 1 µDALY per person per year – Parasitic protozoa(2) (3) The LRV was based on the ratio between **parasitic** protozoa concentration and the **human** adenovirus concentration (MPNIU/L) found in sewage (viruses being present at approximately 0.5 log higher concentrations than **parasitic** protozoa as shown in Table A3.3). For Category 1 sources which have no humans in the catchment a 0 log reduction is set as humans are the predominant source of enteric viruses. (4) The LRV was based on the ratio between **parasitic** protozoa and **enteric** bacteria found in sewage (bacteria being present at approximately 0.5 log higher concentrations than **parasitic** protozoa as shown in Table A3.3) for Category 4 sources.

Table 3: Proposed updates to select ISO and AS/NZS Standards in the Australian Drinking Water Guidelines (4.0)

No.	Section of Guidelines	Current Guidelines text (Version 4.0)	Proposed Guidelines text (Version 4.1)
1	Visit Chapter 1.2.3 Structure of the Guidelines of the Guidelines	**Part I** deals with the management of drinking water quality. Chapter 2 summarises a preventive strategy for the management of drinking water quality. It outlines a Framework for developing the approach; explains the need	**Part I** deals with the management of drinking water quality. Chapter 2 summarises a preventive strategy for the management of drinking water quality. It outlines a Framework for developing the approach; explains the need for water

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No.	Section of Guidelines	Current Guidelines text (Version 4.0)	Proposed Guidelines text (Version 4.1)
	(p5 in PDF)	for water suppliers to work in partnership with other agencies in implementing the Framework; describes the purpose, structure, benefits and application of the Framework; and illustrates how the Framework is related to other management approaches such as Hazard Analysis Critical Control Point (HACCP) and ISO 9001.	suppliers to work in partnership with other agencies in implementing the Framework; describes the purpose, structure, benefits and application of the Framework; and illustrates how the Framework is related to other management approaches such as Hazard Analysis Critical Control Point (HACCP) and **AS ISO 9001:2016**.
2	Visit Chapter 2.1 A preventive strategy from catchment to consumer of the Guidelines **(p14 in PDF)**	In the Australian water industry, risk management and quality management are increasingly being used as a means of assuring drinking water quality by strengthening the focus on more preventive approaches. Some water authorities have implemented management systems based on ISO 9001 Quality Management, ISO 14001 *Environmental Management*, AS/NZS 4360:2004 Risk Management and the Hazard Analysis Critical Control Point (HACCP) system that has been adopted internationally by the food industry.	In the Australian water industry, risk management and quality management are increasingly being used as a means of assuring drinking water quality by strengthening the focus on more preventive approaches. Some water authorities have implemented management systems based on **AS ISO 9001:2016 Quality Management Systems - Requirements, ISO 14001:2016 Environmental Management, AS ISO 31000:2018 Risk Management - Guidelines** and the Hazard Analysis Critical Control Point (HACCP) system that has been adopted internationally by the food industry.
3	Visit Chapter 2.1 A preventive strategy from catchment to consumer of the Guidelines **(p14 in PDF)**	The Framework incorporates a preventive risk management approach; it includes elements of HACCP, ISO 9001 and AS/NZS 4360:2004, but applies them in a drinking water supply context to support consistent and comprehensive implementation by suppliers. The Framework addresses four general areas, which are described below and illustrated in Figure 2.1:	The Framework incorporates a preventive risk management approach; it includes elements of HACCP, **AS ISO 9001:2016 and AS ISO 31000:2018**, but applies them in a drinking water supply context to support consistent and comprehensive implementation by suppliers. The Framework addresses four general areas **(illustrated in Figure 2.1), including:**
4	Visit Chapter 2.6 Correlations of the Framework with other	The Framework is not intended to duplicate or replace management systems that are adequately working; rather, it is intended to be compatible and complementary. The	The Framework is **designed** to be compatible **with** and complementary **to existing management systems. It** includes principles of established systems such **as the Hazard Analysis**

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No.	Section of Guidelines	Current Guidelines text (Version 4.0)	Proposed Guidelines text (Version 4.1)
	systems of the Guidelines **(p19 in PDF)**	Framework includes principles of established systems such as HACCP, ISO 9001 and AS/NZS 4360:2004, and is sufficiently flexible to allow implementation to be built on programs and systems already present in an organisation. However, the relationships between the Framework and these systems should be understood.	**and Critical Control Point** (HACCP) system **(which is also integrated into ISO 22000:2018), AS/NZS ISO 9001:2016 and AS ISO 31000:2018**, and is sufficiently flexible to **build** on programs and systems already present in an organisation. However, the relationships between the Framework and these systems should be understood.
5	Visit Chapter 2.6 Correlations of the Framework with other systems, Table 2.2 Correlations between HACCP and the Framework of the Guidelines	Refer to Appendix C for current Table 2.2	Refer to Appendix C for proposed amendments to Table 2.2
6	Visit Chapter 2.6 Correlations of the Framework with other systems of the Guidelines **(p20 in PDF)**	ISO 9001 provides a generic framework that specifies requirements for quality management systems to address customer satisfaction by assuring a consistent end product. The standard puts emphasis on continuous improvement; it adopts a process model approach that sets out the responsibilities, processes and resources needed to achieve specified objectives with respect to quality.	**AS/NZS ISO 9001:2016** ***Quality management systems – Requirements*** provides a generic framework **for establishing a** quality management system. **The standard aims to ensure products and services meet customer expectations and comply with statutory and regulatory requirements. It also promotes** customer satisfaction by **enabling continual improvement and** assuring a consistent end product. The standard puts emphasis on continuous improvement; it adopts a process model approach **with risk-based thinking** that sets out the responsibilities, processes and resources needed to achieve specified objectives with respect to quality.
7	Visit Chapter 2.6 Correlations of the Framework with other	Table 2.3 lists the detailed ISO 9001 requirements and identifies links and correlations with the Framework. While the Framework and ISO 9001 are compatible, the structures	Table 2.3 lists the detailed **AS/NZS ISO 9001:2016** requirements and identifies links and correlations with the Framework. While the Framework and **AS/NZS ISO 9001:2016** are compatible, the

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No.	Section of Guidelines	Current Guidelines text (Version 4.0)	Proposed Guidelines text (Version 4.1)
	systems of the Guidelines **(p20 in PDF)**	of the two are somewhat different and correlations between them are not as close as those with HACCP. Table 2.3 shows correlations of general themes and areas.	structures of the two are somewhat different and correlations between them are not as close as those with HACCP. Table 2.3 shows correlations of general themes and areas.
8	Visit Chapter 2.6 Correlations of the Framework with other systems, Table 2.3 Correlations between AS/NZS ISO 9001:2016 and the Framework of the Guidelines	Refer to Appendix D for current Table 2.3	Refer to Appendix D for proposed amendments to Table 2.3
9	Visit Chapter 2.6 Correlations of the Framework with other systems of the Guidelines **(p22 in PDF)**	ISO 9001 includes several aspects of the Framework, but in a general sense, and it does not always provide a good fit to the specific requirements of drinking water quality management. The most important limitation of ISO 9001 is that it fails to address the preventive requirements of system analysis, hazard identification and control, and risk assessment, which are all critical for effective management of drinking water quality. There are other limitations in the areas of stakeholder involvement (for stakeholders other than consumers), research and development, management of large-scale emergencies, communication and reporting.	AS/NZS ISO 9001:2016 includes several aspects of the Framework, but in a general sense, and it does not always provide a good fit to the specific requirements of drinking water quality management. The most important limitation of AS/NZS ISO 9001:2016 is that it fails to address the preventive requirements of system analysis, hazard identification and control, and risk assessment, which are all critical for effective management of drinking water quality. There are other limitations in the areas of stakeholder involvement (for stakeholders other than consumers), research and development, management of large-scale emergencies, communication and reporting.
10	Visit Chapter 2.6 Correlations of the Framework with other	There is scope to implement the Framework within the structure of these established systems by expanding them to encompass all the necessary elements for drinking water quality management. For example, when integrated, HACCP and ISO 9001 can satisfy many of the key elements	There is scope to implement the Framework within the structure of these established systems by expanding them to encompass all the necessary elements for drinking water quality management. For example, when integrated, HACCP and AS/NZS ISO 9001:2016 can satisfy many of the key elements

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No.	Section of Guidelines	Current Guidelines text (Version 4.0)	Proposed Guidelines text (Version 4.1)
	systems of the Guidelines **(p22 in PDF)**	for drinking water quality management. However, if established management systems are applied to meet the requirements for management of drinking water quality as outlined in the Framework, then it should be ensured that all the necessary elements of drinking quality management are addressed.	for drinking water quality management. However, if established management systems are applied to meet the requirements for management of drinking water quality as outlined in the Framework, then it should be ensured that all the necessary elements of drinking quality management are addressed.
11	Visit Chapter 2.6 Correlations of the Framework with other systems, Table 2.4 Comparison of features from various management frameworks of the Guidelines	Refer to Appendix E for current Table 2.4	Refer to Appendix E for proposed amendments to Table 2.4
12	Visit Chapter 3.2.3 Hazard identification and risk assessment of the Guidelines **(p31 in PDF)**	An example of an approach to estimating the level of risk is provided in Tables 3.1–3.3. These tables have been adapted from AS/NZS 4360:2004 (Risk Management), and can be modified to meet the needs of an organisation.	An example of an approach to estimating the level of risk is provided in Tables 3.1–3.3. These tables have been adapted from the **Water Safety Plan Manual (WHO 2023)**, and can be modified to meet the needs of an organisation. Add to reference list: World Health Organization. (2023). Water safety plan manual: step-by-step risk management for drinking-water suppliers (2nd ed.). Geneva: World Health Organization
13	Visit Chapter 3.4.5 Materials and chemicals of the Guidelines **(p43 in PDF)**	Contaminants may also be introduced when water comes into contact with materials such as filter media, protective coatings, linings and liners, joining and sealing products, pipes and fittings, valves, meters and other components.	Contaminants may also be introduced when water comes into contact with materials such as filter media, protective coatings, linings and liners, joining and sealing products, pipes and fittings, valves, meters and other components. Materials used

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		Materials used should comply with Australian Standard AS/NZS 4020 *Products for use in contact with drinking water*.	should comply with Australian Standard AS/NZS 4020:2018 ***Testing of products for use in contact with drinking water.***
14	Visit Chapter 4.2.3 Implementation of operational procedures and process control of the Guidelines **(p69 in PDF)**	**Materials and chemicals** Materials and chemicals used in water systems should be suitable for use with drinking water. Chemicals such as disinfectants and coagulants should be evaluated for suitability. Where expertise is limited, small communities are encouraged to seek advice from larger suppliers, or state/territory or local governments. All materials should comply with Australian Standard AS/NZS 4020 *Products for use in contact with drinking water*.	**Materials and chemicals** Materials and chemicals used in water systems should be suitable for use with drinking water. Chemicals such as disinfectants and coagulants should be evaluated for suitability. Where expertise is limited, small communities are encouraged to seek advice from larger suppliers, or state/territory or local governments. All materials should comply with Australian Standard AS/NZS 4020:2018 ***Testing of products for use in contact with drinking water.***
15	Visit Chapter 8.2 Scope and limit of application of this chapter of the Guidelines **(p130 in PDF)**	This chapter does not cover the specialised chemicals used in water treatment for non-potable uses (e.g. chemicals used in industrial boilers and air conditioning cooling towers), nor does it cover the impact on water quality of materials in direct contact with water. Information on these chemicals and impacts is given in Australian Standards AS/NZS 3666.1:2002 *Air handling and water systems of buildings – Microbial control – design, installation and commissioning;* AS/NZS 5667.7:1998 *Water quality – Guidance on sampling of water and steam in boiler plants; and* AS/NZS 4020:2002 *Testing of products for use in contact with drinking water* respectively.	This chapter does not cover the specialised chemicals used in water treatment for non-potable uses (e.g. chemicals used in industrial boilers and air conditioning cooling towers), nor does it cover the impact on water quality of materials in direct contact with water. Information on these chemicals and impacts is given in Australian Standards AS/NZS 3666.1:2002 *Air handling and water systems of buildings – Microbial control – design, installation and commissioning;* AS/NZS 5667.7:1998 *Water quality – Guidance on sampling of water and steam in boiler plants; and* AS/NZS 4020:2018 ***Testing of products for use in contact with drinking water*** respectively.
16	Visit Chapter 9.10.2 Methods of the Guidelines	The whole analytical process, from sampling through to presentation of results, needs to be managed in accordance with sound quality assurance principles and should include quality control checks as part of the quality assurance	The whole analytical process, from sampling through to presentation of results, needs to be managed in accordance with sound quality assurance principles and should include quality control checks as part of the quality assurance process.

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	(p184 in PDF)	process. Quality assurance principles are set out in documents such as ISO 9001, and supported by programs such as the National Association of Testing Authorities (NATA) schemes. Wherever possible, analyses should be undertaken at NATA-accredited laboratories.	Quality assurance principles are set out in documents such as AS/NZS ISO 9001:2016, and supported by programs such as the National Association of Testing Authorities (NATA) schemes. Wherever possible, analyses should be undertaken at NATA-accredited laboratories.
17	Visit the Taste and Odour Fact Sheet of the Guidelines **(p1004 in PDF)**	**Treatment of drinking water** [*unchanged text omitted*] If materials used in distribution systems result in discernable tastes and odours, then replacement of the materials or *in situ* lining of the pipework is recommended. The use of non-return devices or back-flow prevention devices can eliminate taste and odour issues associated with the back-siphoning of water, including hoses attached to dishwashers and washing machines installed within close proximity to a draw-off point. The introduction of the Australian and New Zealand Standard AS/NZS 4020 (2005) to ensure materials used in contact with water comply with a range of tests, including the formation of taste under standard test conditions, should eventually eliminate taste and odour problems associated with materials in contact with drinking water. However the interaction of disinfected water with components such as plastics in customers' kettles or new plumbing can be more difficult to control.	**Treatment of drinking water** [*unchanged text omitted*] If materials used in distribution systems result in discernible tastes and odours, then replacement of the materials or *in situ* lining of the pipework is recommended. The use of non-return devices or back-flow prevention devices can eliminate taste and odour issues associated with the back-siphoning of water, including hoses attached to dishwashers and washing machines installed within close proximity to a draw-off point. The introduction of the Australian and New Zealand Standard AS/NZS 4020 (2018) to ensure materials used in contact with water comply with a range of tests, including the formation of taste under standard test conditions, should eventually eliminate taste and odour problems associated with materials in contact with drinking water. However, the interaction of disinfected water with components such as plastics in customers' kettles or new plumbing can be more difficult to control.
18	Visit the Taste and Odour Fact Sheet of the Guidelines	**Operational guideline for MIB/geosmin** The major cause of taste and odour episodes in Australian water supplies is the presence of MIB and/or geosmin. Based on experience in water utilities, action based on	**Operational guideline for MIB/geosmin** The major cause of taste and odour episodes in Australian water supplies is the presence of 2-methylisoborneol (MIB) and/or geosmin. Based on experience in water utilities, action based on

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	(p1004-1005 in PDF)	concentrations of MIB/geosmin suggested below will help to minimise customer complaints. [*unchanged text omitted*] **At treatment plant outlet** Total MIB and/or geosmin >10 ng/L Introduce powdered activated carbon dosing to treatment plant Regular measurement and identification of algae should also be undertaken to complement MIB/geosmin analysis at the inlet to the water treatment plant. Depending on the species-specific relationship between cell numbers and MIB/geosmin concentrations, additional monitoring may be necessary at the treatment plant inlet when algal organisms known to be producers of these compounds exceed approximately 1000 cells/mL.	concentrations of MIB/geosmin suggested below will help to minimise customer complaints. [*unchanged text omitted*] **At treatment plant outlet** Total MIB and/or geosmin >10 ng/L Introduce powdered activated carbon dosing to treatment plant Regular measurement and identification of algae**/cyanobacteria** should also be undertaken to complement MIB/geosmin analysis at the inlet to the water treatment plant. Depending on the species-specific relationship between cell numbers and MIB/geosmin concentrations, additional monitoring may be necessary at the treatment plant inlet **when organisms** known to be producers of these compounds exceed approximately 1000 cells/mL.
19	Visit the Taste and Odour Fact Sheet of the Guidelines **(p1005 in PDF)**	**References** [*unchanged text omitted*] AS/NZS (2005). *Testing of products for use in contact with drinking water*, AS/NZS 4020:2005. Standards Australia, Standards New Zealand.	**References** [*unchanged text omitted*] **AS/NZS (2018). *Testing of products for use in contact with drinking water*, AS/NZS 4020:2018.** Standards Australia, Standards New Zealand.
20	Visit A1.5 Risk assessment of the Guidelines **(p1178 in PDF)**	An example of an approach to estimating the level of risk is provided in Tables A1.4, A1.5 and A1.6. These tables have been adapted from AS/NZS 4360:1999 *Risk Management* and can be modified to meet the needs of an organisation.	An example of an approach to estimating the level of risk is provided in Tables A1.4, A1.5 and A1.6. These tables have been adapted from **Water Safety Plan (WHO 2023)** and can be modified to meet the needs of an organisation.

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21	Visit A2.4 Risk assessment and management of the Guidelines **(p1194 in PDF)**	AS/NZS 3931 (Australian Standard/New Zealand Standard) (1998). Risk analysis of technological systems — application guide. Standards Australia/Standards New Zealand. AS/NZS 4360(Australian Standard / New Zealand Standard) (1999). Risk management. Standards Australia/Standards New Zealand. AS/NZS ISO 14001 (Australian Standard/New Zealand Standard, International Organization for Standardization) (1996). Environmental management systems — specification with guidance for use. Standards Australia/Standards New Zealand. AS/NZS ISO 14004 (Australian Standard/New Zealand Standard, International Organization for Standardization) (1996). Environmental management systems — general guidelines on principles, systems and supporting techniques. Standards Australia/Standards New Zealand.	~~AS/NZS 3931 (Australian Standard/New Zealand Standard) (1998). Risk analysis of technological systems — application guide. Standards Australia/Standards New Zealand.~~ AS/NZS ISO 14001 (Australian Standard/New Zealand Standard, International Organization for Standardization) **(2016)**. Environmental management systems — specification with guidance for use. Standards Australia/Standards New Zealand. AS/NZS ISO 14004 (Australian Standard/New Zealand Standard, International Organization for Standardization) **(2011)**. Environmental management systems — general guidelines on principles, systems and supporting techniques. Standards Australia/Standards New Zealand. **AS ISO 31000 (Australian Standard / New Zealand Standard) (2018).** Risk management - Guidelines. Standards Australia/Standards New Zealand.
22	Visit A2.7 Materials and chemicals of the Guidelines **(p1196 in PDF)**	AS/NZS 4020 (Australian Standard/New Zealand Standard) (1999). Products for use in contact with drinking water. Standards Australia/Standards New Zealand.	AS/NZS 4020 (Australian Standard/New Zealand Standard) (**2018**). Testing of products for use in contact with drinking water. Standards Australia/Standards New Zealand.
23	Visit A2.14 Quality management/	AS/NZS ISO 9001 (2000). Quality management systems — requirements. Standards Australia/Standards New Zealand.	AS/NZS ISO 9001 (**2016**). Quality management systems — requirements. Standards Australia/Standards New Zealand.

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	continuous improvement of the Guidelines **(p1198 in PDF)**	[*unchanged text omitted*] AS/NZS ISO 14001 (1996). Environmental management systems — specification with guidance for use. Standards Australia/Standards New Zealand.	[*unchanged text omitted*] AS/NZS ISO 14001 (2016). Environmental management systems — specification with guidance for use. Standards Australia/Standards New Zealand.
24	Visit the Glossary, ISO 9001:2000 (Quality Management) of the Guidelines **(p1221 in PDF)**	ISO 9001:2000 (Quality Management): an international accredited standard that provides a generic framework for quality management systems. Designed to assure conformance to specified requirements by a supplier at all stages during the design, development, production, installation, and servicing of a product, it sets out the requirements needed to achieve an organisation's aims with respect to guaranteeing a consistent end product.	AS/NZS ISO 9001:2016 (Quality Management Systems - Requirements): an international accredited standard that provides a generic framework for quality management systems. Designed to assure conformance to specified requirements by a supplier at all stages during the design, development, production, installation, and servicing of a product, it sets out the requirements needed to achieve an organisation's aims with respect to guaranteeing a consistent output.
25	Visit the Glossary, ISO 14001:1996 (Environmental Management Systems) of the Guidelines **(p1221 in PDF)**	ISO 14001:1996 (Environmental Management Systems): an international accredited standard that provides a generic framework for guidance on the development and implementation of an environmental management system to minimise the impacts of business operations on the environment and to foster environmental sustainability.	ISO 14001:2016 (Environmental Management Systems): an international accredited standard that provides a generic framework for guidance on the development and implementation of an environmental management system to minimise the impacts of business operations on the environment and to foster environmental sustainability.
26	Visit the Glossary, risk assessment of the Guidelines **(p1223 in PDF)**	risk assessment: the overall process of using available information to predict how often hazards or specified events may occur (likelihood) and the magnitude of their consequences (adapted from AS/NZS 4360:1999).	risk assessment: the overall process of using available information to predict how often hazards or specified events may occur (likelihood) and the magnitude of their consequences (adapted from Water Safety Plan (WHO 2023)).

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Table 4: Proposed 'other' amendments to the Australian Drinking Water Guidelines (Version 4.0)

No.	Section of Guidelines	Current Guidelines text (Version 4.0)	Proposed Guidelines text (Version 4.1)
1	Visit Chapter 1.3.2 Health-based targets of the Guidelines **(p6 of PDF)**	Health-based targets provide quantifiable metrics for [*unchanged text omitted*] reference value for radiological activity (Figure 1.3). The health outcome for microbiological safety is an upper limit of 1 x 10^{-6}Disability Adjusted Life Years (1 µDALY) per person per year. The target is used as the basis for defining treatment performance targets based on source water quality as discussed in Chapter 5 and Appendix 3.	Health-based targets provide quantifiable metrics for [*unchanged text omitted*] reference value for radiological activity (Figure 1.3). The health outcome for microbiological safety is an upper limit of 1 x 10^{-6}Disability Adjusted Life Years (1 µDALY) per person per year **for the total population**. The target is used as the basis for defining treatment performance targets based on source water quality as discussed in Chapter 5 and Appendix 3.
2	Visit Chapter 3.2.3 Hazard identification and risk assessment of the Guidelines **(p31 of PDF)**	**Unforeseen and rare events** In well managed systems, problems should be rare, making them more challenging to anticipate and possibly to counter. This highlights the need to learn constructive lessons from the experiences of other Australian and international drinking water suppliers and water agencies. Many problems are triggered by short periods of sudden change, such as heavy rainfall or equipment failure. There are catalogues of waterborne disease outbreaks and the events that caused them. Some of these events should have been foreseeable while others have been attributable to more unusual or rare events. Maintaining awareness of such incidents can enable preventive measures to be implemented, to safeguard against similar occurrences (see Box 3.3 in Section 3.4).	**Unforeseen and rare events** In well managed systems, problems should be rare, making them more challenging to anticipate and possibly to counter. This highlights the need to learn constructive lessons from the experiences of other Australian and international drinking water suppliers and water agencies. Many problems are triggered by short periods of sudden change, such as heavy rainfall or equipment failure. There are catalogues of waterborne disease outbreaks and the events that caused them. Some of these events should have been foreseeable while others have been attributable to more unusual or rare events **(Hrudey and Hrudey 2019)**. Maintaining awareness of such incidents can enable preventive measures to be implemented, to safeguard against similar occurrences (see Box 3.3 in Section 3.4).
3	Visit Chapter 3.3.1 Preventive measures	**Disinfection**	**Disinfection**

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	and multiple barriers of the Guidelines **(p36 of PDF)**	The most commonly used disinfection processes are chlorination and chloramination, but ozone, ultraviolet irradiation and chlorine dioxide are also used. These methods are very effective in killing bacteria and can be reasonably effective in inactivating viruses (depending on type) and many protozoa, including *Giardia. Cryptosporidium* is not inactivated by the concentrations of chlorine and chloramines that can be safely used in drinking water, and the effectiveness of ozone and chlorine dioxide is limited with this organism. However, there is some evidence that ultraviolet light might be effective in inactivating *Cryptosporidium*, and that combinations of disinfectants can enhance inactivation. Storage of water after disinfection and before supply to consumers can improve disinfection by increasing contact times. This can be particularly important for microorganisms, such as *Giardia* and viruses.	The most commonly used disinfection processes are chlorination and chloramination, but ozone, ultraviolet irradiation and chlorine dioxide are also used. These methods are very effective in killing bacteria and can be reasonably effective in inactivating viruses (depending on type) and *Giardia* **cysts with UV or ozone being more useful for inactivating parasitic protozoan oo/cysts**. *Cryptosporidium* **oocysts are** not inactivated by the concentrations of chlorine and chloramines that can be safely used in drinking water, and the effectiveness of chlorine **dioxide and ozone at low temperatures** is limited. Storage of water after **chemical** disinfection and before supply to consumers can improve disinfection by increasing contact times. This can be particularly important for microorganisms, such as *Giardia* and viruses. Add to reference list: **Hrudey SE and Hrudey EJ (2019). Common themes contributing to recent drinking water disease outbreaks in affluent nations. *Water Supply*, 19, 1767-1777**
4	Visit Chapter 3.9 Research and development (element 9), Box 3.7 The Melbourne water quality study of the Guidelines **(p55-56 of PDF)**	**The Melbourne water quality study** The Melbourne water quality study is an example of a large-scale, high-quality research study made possible through the collaboration of several organisations. The study was carried out by university researchers with the involvement of four water utilities, and was funded jointly by the water industry and the health regulator.	**The Melbourne water quality study** The Melbourne water quality study is an example of a large-scale, high-quality research study made possible through the collaboration of several organisations. The study was carried out by university researchers with the involvement of four water utilities and was funded jointly by the water industry and the health regulator.

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		The study investigated the effect of microbial water quality on rates of community gastroenteritis in Melbourne by measuring the difference in the levels of illness among two population groups, each comprising approximately 300 households. One group consumed normal tap water and the other consumed water that was filtered and disinfected with ultraviolet radiation. The principal aim of the study was to determine whether additional treatment of drinking water was necessary for an area served by a disinfected but unfiltered water supply drawn from protected catchments. The study used stringent epidemiological methodology and found no measurable difference in illness rates between the normal tap water group and the filtered water group, thus demonstrating that Melbourne's unfiltered drinking water does not make a significant contribution to gastroenteritis rates. This groundbreaking project successfully addressed a water quality issue of international importance by shifting the focus from testing the microbial quality of drinking water to studying the health effects of drinking water. The study was a major undertaking but was completed for less than 1 per cent of the cost of building a water treatment plant. Information from this research will enable better informed decisions about the management of Melbourne's water. Furthermore, the study has established a new methodology to assess the health effects of drinking water quality that is	The study investigated the effect of microbial water quality on rates of community gastroenteritis in Melbourne by measuring the difference in the levels of illness among two **randomised** groups, each comprising approximately 300 households. **Unknowingly** one group consumed normal tap water **through a sham filter** and the other consumed water that was filtered and disinfected with ultraviolet radiation – **i.e. a double blinded, randomised controlled trial, the gold standard in epidemiology studies.** The principal aim of the study was to determine whether additional treatment of drinking water was necessary for an area served by a disinfected but unfiltered water supply drawn from protected catchments. **Using robust epidemiological methods, the study found no detectable difference in gastroenteritis rates between participants consuming Melbourne tap water and those using filtered/UV disinfected water. Importantly, the study was sufficiently sensitive that an effect would have been detected had more than 10% of participants developed illness, reinforcing the conclusion that Melbourne's unfiltered drinking water does not materially contribute to gastroenteritis rates.** This groundbreaking project successfully addressed a water quality issue of international importance by shifting the focus from testing the microbial quality of drinking water to studying the health effects of drinking water. The study was a major undertaking but was completed for less than 1 per cent of the cost of building a water treatment plant. Information from this research enabled better informed decisions about the management of Melbourne's water.

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		being employed in other cities to answer similar questions for different types of water supplies. Source: Hellard et al. (2001)	Furthermore, the study established a new methodology to assess the health effects of drinking water quality that is being employed in other cities to answer similar questions for different types of water supplies. Source: Hellard et al. (2001)
5	Visit Chapter 3.9 Research and development (element 9), Box 3.7 The Melbourne water quality study of the Guidelines **(p55-56 of PDF)**	*[Intentionally blank]*	**NOTE:** The following text is to complement 'The Melbourne water quality study' in Box 3.7. It includes the Melbourne catchment and other major Australian catchments and highlights hazardous event risk changes by catchment type. **Box 3.7: The Cooperative Research Centre for Water Quality and Treatment Project** An example of collaborative research in the Australian water sector is the Cooperative Research Centre for Water Quality and Treatment (CRC WQT) project on source water quality assessment and pathogen management (Roser and Ashbolt 2007). This initiative brought together 24 organisations, including water utilities, universities and government agencies, from across Australia. The project aimed to improve understanding of pathogen behaviour in Australian freshwater catchments to our larger cities, and to improve management guidance aligned with the risk-management framework of the Guidelines. The study collected and analysed comprehensive water quality data from eight systems (six surface waters and two aquifers), each supplying between 10,000 and 100,000 customers in southern Australia. Analyses included

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			pathogens, faecal indicator bacteria, chemical biomarkers, physical and chemical parameters, and particle size data, complemented by rainfall and flow information. This multi-catchment study demonstrated that microbial concentrations in source waters are highly variable—greatly exceeding the variability observed in physical and chemical parameters, with levels changing by one or two orders of magnitude within 24 hours due to natural, baseline variation. Most importantly, rainfall-induced runoff could result in pathogen loads several orders of magnitude higher than baseline conditions, with a single event potentially exporting three hundred years' worth of dry-weather contamination in one day. Also, the source of pathogens varied to that of faecal indicators, due to their differential behaviours under varying rainfall and catchment saturation levels. For groundwater systems, enterococci were more frequently encountered than *E. coli* and were preferred for timely warning of faecal contamination. These findings highlight the importance of event-based monitoring and dynamic risk management and preventive measures using multiple targets. Also, that systems are under greatest pressure during wet weather events, and for comparative studies, in the importance of quality control materials — given analytic recoveries between samples could vary greatly (e.g., <1% to 60% for *Cryptosporidium* oocysts recoveries). Overall, this collaborative research emphasise that risk management activities should focus on wet weather event management, and preventive measures should be effective during wet weather events when management systems are

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			likely to be under greater pressure. Additionally, catchment risk management categories could be qualitatively grouped based on level of anthropogenic impact, catchment size and runoff condition (baseline, small-event or large-event). Lastly, while catchment protection is essential, it shouldn't be relied upon alone; treatment barriers such as disinfection remain critical for managing pathogen risks. The event sampling protocols and approaches for pathogen monitoring, management and risk assessment, designed and tested under Australian conditions in this project, provide a practical basis for improved risk-based management that could be adapted for other catchments. Source (Roser and Ashbolt 2007) Add to references: Roser DJ and Ashbolt NJ (2007). Source Water Quality Assessment and the Management of Pathogens in Tributaries and Aquifers. Research Report 29 for the CRC for Water Quality and Treatment, Adelaide, SA.
6	Visit Chapter 4.2.2 Preventive measures for drinking water quality management of the Guidelines **(p68 of PDF)**	**Surface water** Assurance of quality from surface water sources is more difficult than from most groundwater or rainwater systems. In general, surface waters will require at least disinfection, and in some cases filtration, to assure microbial safety. However, as for groundwater systems, the first barrier is to prevent contamination at source by minimising contamination from human waste, livestock and other hazards as discussed above. The greater the degree of protection of the water source, the less the reliance on	**Surface water** Assurance of quality from surface water sources is more difficult than from most groundwater or rainwater systems. In general, surface waters will require at least disinfection, and in **most** cases filtration, to assure microbial safety **and to comply with the multibarrier approach advocated in the Guidelines**. However, as for groundwater systems, the first barrier is to prevent contamination at source by minimising contamination from human waste, livestock and other hazards as discussed above. The greater the degree of

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		treatment and disinfection. After treatment or disinfection, water should be protected during delivery to consumers in the same manner as groundwater, by ensuring that distribution systems are enclosed. See Section 5.4.2 for information on contamination of source waters with enteric pathogens.	protection of the water source, the less the reliance on treatment and disinfection. After treatment or disinfection, water should be protected during delivery to consumers in the same manner as groundwater, by ensuring that distribution systems are enclosed **and restrict human and animal access**. See Section 5.4.2 for information on contamination of source waters with enteric pathogens.
7	Visit Chapter 4.2.4 Verification of drinking water quality of the Guidelines **(p69 of PDF)**	Verification of drinking water quality is described.... In systems where disinfection is used, evidence of continuous operation is very important in providing assurance of microbial quality. Disinfection is very effective against bacterial pathogens but less so against viruses and enteric protozoa (e.g. Giardia and Cryptosporidium). The presence of viruses and protozoa can be minimised by protecting water supplies from human and livestock waste. If chlorination is used, the presence of a free chlorine residual in the distribution system provides evidence of initial disinfection and protection against recontamination from backflow, pipeline breaks or other causes. The amount of chlorine required varies with the flow rate, the quality of the raw water and other factors. Generally, a free chlorine residual of between 0.2 and 0.5 mg/L is adequate.	Verification of drinking water quality is described.... In systems where disinfection is used, evidence of continuous operation is very important in providing assurance of microbial quality. Disinfection **of water with chlorine can be** very effective against bacteria and viruses. **Enteric protozoan oocysts such as those from *Cryptosporidium* and *Giardia* spp. can be inactivated by UV light. More information is provided in Table 5.6.** The presence of viruses and protozoa can also be minimised by protecting water supplies from human and livestock waste. If chlorination is used, the presence of a free chlorine residual in the distribution system provides evidence of initial disinfection and **may** protect against recontamination from backflow, pipeline breaks, **pressure transients** or other causes. The amount of chlorine required varies with the flow rate, the quality of the raw water and other factors **that impact on chlorine demand**. Generally, a free chlorine residual of between 0.2 and 0.5 mg/L is adequate **if maintained**.
8	Visit Chapter 8.8 Contaminants in drinking water treatment	**Sample calculation for determining the lead recommended maximum impurity concentration in Alum**	**Sample calculation for determining the lead recommended maximum impurity concentration in alum**

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	chemicals, Box 8.3 Sample calculation for determining the lead recommended maximum impurity concentration in Alum of the Guidelines **(p145 of PDF)**	Please refer to Appendix F for current Box 8.3	Please refer to Appendix F for proposed amendments to Box 8.3
9	Visit Chapter 8.8 Contaminants in drinking water treatment chemicals, Table 8.4 Recommended maximum impurity concentrations for selected drinking water treatment chemicals of the Guidelines **(p147 of PDF)**	**Recommended maximum impurity concentrations for selected drinking water treatment chemicals** Please refer to Appendix G for current Table 8.4	**Recommended maximum impurity concentrations for selected drinking water treatment chemicals** Please refer to Appendix G for proposed amendments to Table 8.4
10	Visit Chapter 9.5.2 Drinking water quality monitoring of the Guidelines **(p173 of PDF)**	Drinking water quality monitoring is used to provide assurance that the quality of drinking water in the distribution system, as supplied to the consumer, is meeting guideline values, agreed levels of service, and/or any regulatory requirements. It can provide an additional means of detecting any unrecognised problems that may be occurring upstream or within the distribution system, and can trigger the necessary corrective actions.	Drinking water quality monitoring is used to provide assurance that the quality of drinking water in the distribution system, as supplied to the consumer, is meeting guideline values, microbial health-based targets, agreed levels of service, and/or any regulatory requirements. It can provide an additional means of detecting any unrecognised problems that may be occurring upstream or within the distribution system, and can trigger the necessary corrective actions.

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No.	Section of Guidelines	Current Guidelines text (Version 4.0)	Proposed Guidelines text (Version 4.1)
11	Visit Chapter 10.2.1 Short-term evaluation of operational monitoring of the Guidelines **(p202 of PDF)**	Operational monitoring is carried out throughout the water system, including source water and catchment, treatment processes, and the distribution system **[*unchanged text omitted*]** When target criteria and/or critical limits (for critical control points) have not been met, operational staff need to remain aware that the water supply system may not be functioning effectively, and assess the immediate or future risk of supplying unacceptable and possibly unsafe water to consumers. Box 10.1 sets out priorities for attention when operational characteristics are found to deviate from established operational criteria.	Operational monitoring is carried out throughout the water system, including source water and catchment, treatment processes, and the distribution system **[*unchanged text omitted*]** When target criteria and/or critical limits (for critical control points) have not been met, operational staff need to remain aware that the water supply system may not be functioning effectively, and assess the immediate or future risk of supplying unacceptable and possibly unsafe water to consumers. **The evaluation should include relevant operational data to determine whether corrective actions are required to restore effective treatment performance (See Chapter 5).** Box 10.1 sets out priorities for attention when operational characteristics are found to deviate from established operational criteria.
12	Visit Chapter 10.3.7 Summary of guideline values for microbial, chemical and physical characteristics, Table 10.6 Guideline values for physical and chemical characteristics of the Guidelines **(p210-225 in PDF)**	**Table 10.6 Guideline values for physical and chemical characteristics** *[Third column, 46th row]* 0.6 *[Aesthetic-based guideline value for Chlorine of 0.6 mg/L]* *[Second column, 80th row]* 0.005 *[Health-based guideline value for Diclofop-methyl of 0.005 mg/L]*	**Table 10.6 Guideline values for physical and chemical characteristics** *[Third column, 46th row]* ~~0.6~~ *[Removal of the aesthetic-based guideline value for Chlorine of 0.6 mg/L]* *[Second column, 80th row]* 0.004

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No.	Section of Guidelines	Current Guidelines text (Version 4.0)	Proposed Guidelines text (Version 4.1)
			[Updating of the health-based guideline value for Diclofop-methyl to 0.004 mg/L]
13	Visit the Naegleria fowleri fact sheet in the Guidelines **(p365 of PDF)**	**Australian significance** PAM cases have been recorded from South Australia, Western Australia, Queensland and New South Wales; *Naegleria fowleri* has been detected in water in each of these states and in the Northern Territory. Australia is the only country where *N. fowleri* has been detected in public water supplies (Dorsch et al. 1983). Most of the available data on the density of *N. fowleri* in water relates to water supplies in South Australia (including the highest reported densities). In temperate Australia, significant seasonal cycles of density occur, from below one organism per litre to hundreds or thousands per litre in poorly disinfected water (Robinson and Christy 1984). *N. fowleri* detected at water temperatures below 18°C is likely to be present as cysts, which are not infectious, but which may seed a suitable environment.	**Australian significance** PAM cases have been recorded from South Australia, Western Australia, Queensland and New South Wales; *Naegleria fowleri* has been detected in water in each of these states and in the Northern Territory. Australia, **along with the United States, China, India, Pakistan, and the UK, is one of an increasing number of countries** where *N. fowleri* has been detected in public water supplies (Dorsch et al. 1983; **Miller et al. 2018; Rîpā et al. 2025**). Most of the available data on the density of *N. fowleri* in water relates to water supplies in South Australia (including the highest reported densities). In temperate Australia, significant seasonal cycles of density occur, from below one organism per litre to hundreds or thousands per litre in poorly disinfected water (Robinson and Christy 1984). *N. fowleri* detected at water temperatures below 18°C is likely to be present as cysts, which are not infectious, but which may seed a suitable environment. Add to reference list: **Miller HC, Wylie JT, Kaksonen AH, Sutton D, Puzon GJ (2018). Competition between *Naegleria fowleri* and free living amoeba colonizing laboratory scale and operational drinking water distribution systems. *Environ Sci Technol*. 2018 Mar 6;52(5): 2549-2557.** **Rîpā C, Cobzaru RG, Rîpā MR, Mastaleru A, Oancea A, Cumpāt CM and Leon MM (2025). *Naegleria fowleri* infections:**

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No.	Section of Guidelines	Current Guidelines text (Version 4.0)	Proposed Guidelines text (Version 4.1)
			Bridging clinical observations and epidemiological insights. J Clin Med 14(2): 526.
14	Visit the Diclofop-methyl fact sheet in the Guidelines (p620 in PDF)	**Guideline** *Based on human health concerns, diclofop-methyl in drinking water should not exceed 0.005 mg/L.* **Derivation of health-based guideline** The health-based guideline of 0.005 mg/L for diclofop-methyl was determined as follows: $0.005\ \text{mg/L} = \frac{0.25\ \text{mg/kg bodyweight/day x 70 kg x 0.1}}{2\ \text{L/day x 200}}$ where: • 0.25 mg/kg bw/day is the NOEL based on a long-term (2-year) dietary study in mice. • [*unchanged text omitted*] • 200 is the safety factor applied to the NOEL derived from animal studies. This safety factor incorporates a factor of 10 for interspecies extrapolation, 10 for intraspecies variation and 2 for uncertainty due to potential for tumour promotion.	**Guideline** *Based on human health concerns, diclofop-methyl in drinking water should not exceed 0.004 mg/L.* **Derivation of health-based guideline** The health-based guideline of 0.004 mg/L (rounded) for diclofop-methyl was determined as follows: $0.004\ \text{mg/L} = \frac{0.25\ \text{mg/kg bodyweight / day x 70 kg x 0.1}}{2\text{L / day x 200}}$ where: • 0.25 mg/kg bw/day is the NOEL based on a long-term (2-year) dietary study in mice. • [*unchanged text omitted*] • 200 is the safety factor applied to the NOEL derived from animal studies. This safety factor incorporates a factor of 10 for interspecies extrapolation, 10 for intraspecies variation and 2 for uncertainty due to potential for tumour promotion. The calculated value of 0.004375 mg/L is rounded to a health-based guideline value of 0.004 mg/L as per the rounding conventions described in Chapter 6.

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No.	Section of Guidelines	Current Guidelines text (Version 4.0)	Proposed Guidelines text (Version 4.1)
15	Visit the Copper sulfate fact sheet in the Guidelines **(p1114 of PDF)**	[*unchanged text omitted*] **General description** Copper sulfate, $CuSO_4$, is a blue crystal, or blue crystalline granule or powder, but is white when dehydrated. The chemical has a nauseous metallic taste and is poisonous. The anhydrous form contains nearly 50% copper; the commonly used pentahydrate form ($CuSO_4 \cdot 5H_2O$) contains 25.5% copper.	[*unchanged text omitted*] **General description** Copper sulfate, $CuSO_4$, is a blue crystal, or blue crystalline granule or powder, but is white when dehydrated. The chemical has a nauseous metallic taste and is poisonous. The anhydrous form contains nearly **40%** copper; the commonly used pentahydrate form ($CuSO_4 \cdot 5H_2O$) **for algae and cyanobacteria control** contains **25%** copper.
16	Visit A1.7 Critical control points, Table A1.10 Example – potential critical control points and operational criteria of the Guidelines (p1188 in PDF)	See Appendix H for current Table A1.10	See Appendix H for proposed amendments to Table A1.10
17	Visit the Glossary, disinfection byproduct of the Guidelines **(p1219 of PDF)**	products of reactions between disinfectants, particularly chlorine, and naturally occurring organic material.	products of reactions between disinfectants **(such as chlorine),** and **chemicals or** naturally occurring organic material **that remain in water after a given disinfectant contact time under specified conditions**.
18	Visit the Glossary, guideline value of the Guidelines	the concentration or measure of a water quality characteristic that, based on present knowledge, either does not result in any significant risk to the health of the	the concentration **range or limit** of a water quality characteristic that, based on present knowledge, either does not result in any significant risk to the health of the consumer (health-based

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No.	Section of Guidelines	Current Guidelines text (Version 4.0)	Proposed Guidelines text (Version 4.1)
	(p1220 of PDF)	consumer (health-based guideline value), or is associated with good quality water (aesthetic guideline value).	guideline value), or is associated with good quality water (aesthetic guideline value)
19	Visit the Glossary, radionuclide of the Guidelines **(p1223 of PDF)**	an isotope of an element that is unstable and undergoes radioactive decay.	an element that has excess nuclear energy, making it unstable. Thus, radionuclides undergo radioactive 'decay', emitting ionising radiation in the process.
20	Multiple This is an edit proposed to be actioned as part of the update, which may have multiple occurrences within the Guidelines	***[Intentionally blank]***	Throughout the Guidelines, the terms *'meeting the target', 'achieving the target'* '*meeting the treatment targets', 'achieving the target', 'achieving a required treatment target' and 'achieving the targets'* are used interchangeably. For consistency and standardisation of terminology, it is proposed that *'meeting'* be used instead of '*achieving*' in all instances.
21	Multiple This is an edit proposed to be actioned as part of the update, which may have multiple occurrences within the Guidelines	***[Intentionally blank]***	General corrections throughout the Guidelines that relate to: (1) words spelt incorrectly, (2) punctuation, and (3) formatting of words and text.

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Appendices

APPENDIX A – Current Table 5.6. Visit Table 5.6 Indicative pathogen LRV potentially attributable to treatment barriers of the Guidelines.

Treatment barriers	Validated LRVs[1]			Basis for validation
	Protozoa	Virus	Bacteria	
Conventional filtration: Coagulation, flocculation, sedimentation (or dissolved air flotation) and media filtration	2.5-4	2	2	Accepted industry norms.[2] Performance depends on design, management and operational effectiveness and good supporting practices. On-line monitoring of filtered water turbidities; maintaining turbidities below defined critical limits measured by nephelometric turbidity units (NTU) (e.g. <0.2 NTU); minimising turbidity spikes and controlling filter backwash and recycling procedures are consistent with achieving higher LRVs.
Direct filtration: Coagulation, flocculation and media filtration	2-3.5	1	1	Lack of sedimentation in direct filtration reduces maximum removals by 0.5-1 LRV.
Microfiltration or ultrafiltration (MF/UF)	4	0	4	Published validation protocol.[3] Maintaining individual filter turbidities below defined critical limits (e.g. ≤ 0.1 NTU). Daily Membrane Integrity Test (MIT) to manufacturer's specification for the required LRV. UF typically achieves higher LRVs.
Chlorine	0	4	4	Published inactivation data and validation protocol. [4] *Virus* C.t $_{99.99}$ 6 mg.min/L at pH 7, 10°C, turbidity <2 NTU [5] C.t$_{99.99}$ 16 mg.min/L at pH 8, 10˚C and turbidity <2 NTU[5] *Bacteria* C.t$_{99.99}$ <1 mg.min/L at pH 6-9, 10˚C-15˚C, and turbidity ≤1NTU. [5] For bacteria and viruses, a default of 15 mg.min/L is given as an acceptable value in the Guidelines (See also Information Sheet 1.3).

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Chloramine	0	4	4	Published inactivation data.[5] *Virus* $C.t_{99.99}$ 3100 mg.min/L at pH 7, 10˚C, turbidity ≤2NTU[5] $C.t_{99.99}$ 3970 mg.min/L at pH 8, 10˚C, turbidity ≤2NTU[5] $C.t_{99.99}$ 6870 mg.min/L at pH 9, 10˚C, turbidity ≤2NTU[5] *Bacteria* $C.t_{99.99}$ 360 mg.min/L at pH 8-9, ≥5˚C, turbidity ≤1NTU (See also Information Sheet 1.4).
Ultraviolet light disinfection (UV)	4	4	4	Published inactivation data and validation protocol.[7] UV dose of 186 mJ/cm^2 can provide 4 log inactivation of viruses and 22 mJ/cm^2 can provide 4 log inactivation of protozoa and bacteria. (See also Information Sheet 1.7)
Ozone	4	4	4	Published inactivation data and validation protocol.[8] *Virus* $C.t_{99.99}$ ≥1.2 mg.min/L at pH 6-9, ≥5˚C, turbidity ≤1NTU *Protozoa*[5] $C.t_{99.99}$ ≥64 mg.min/L at pH 6-9, ≥5˚C, turbidity ≤1NTU *Bacteria*[5] $C.t_{99.99}$ ≥0.04 mg.min/L at pH 6-9, ≥5˚C, turbidity ≤1NTU[5] (See also Information Sheet 1.6)
Reverse osmosis (RO)	1.5-2 2.5-4	1.5-2 2.5-4	1.5-2 2.5-4	Published validation protocol.[9] Validated LRVs limited by sensitivity of operational monitoring. Based on on-line operational monitoring of EC or TOC. Based on on-line or off-line operational monitoring of sulfate or fluorescent dyes.

[1] LRVs can only be claimed if meeting requirements described in published material or by certification against validation protocols (as cited for individual processes) (see Chapter 9 and Victorian Department of Health 2013).

[2] USEPA 2006 (also see Turbidity Fact Sheet).

[3] USEPA 2005.

[4] Keegan et al. 2012 (see Information Sheet 1.3 “Disinfection with Chlorine”); WaterVal 2017a.

[5] Concentration (C) and the corresponding disinfectant contact time (t) in minutes (C·t).

[6] Keegan et al. 2012 (see Information Sheet 1.4 “Chloramines”).

[7] (see Information Sheet 1.7 “Disinfection with Ultraviolet Light”); WaterVal 2017b.

[8] (see Information Sheet 1.6 “Disinfection with Ozone”); WaterVal 2017c.

[9] WaterVal 2017d.

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Appendix A: Proposed amendments to Table 5.6: Indicative pathogen LRV potentially attributable to treatment barriers

Treatment barriers	Validated LRVs[1]			Basis for validation
	Protozoa	Virus	Bacteria	
Conventional filtration: Coagulation, flocculation, sedimentation (or dissolved air flotation) and media filtration	2.5-4	2	2	~~Accepted industry norms~~ Refer to Turbidity Fact Sheet and US EPA 2006. Performance depends on design, management and operational effectiveness and good supporting practices. On-line monitoring of filtered water turbidities; maintaining turbidities below defined critical limits measured by nephelometric turbidity units (NTU) (e.g. <0.2 NTU); minimising turbidity spikes and controlling filter backwash and recycling procedures are consistent with achieving higher LRVs.
Direct filtration: Coagulation, flocculation and media filtration	2-3.5	1	1	Lack of sedimentation in direct filtration reduces maximum removals by 0.5-1 LRV.
Microfiltration or ultrafiltration (MF/UF)	4	0	4	Published validation protocol.~~23~~ Maintaining individual filter turbidities below defined critical limits (e.g. ≤ 0.1 NTU). Daily Membrane Integrity Test (MIT) to manufacturer's specification for the required LRV. UF typically achieves higher LRVs.
Chlorine	0	4	4	Published inactivation data and validation protocol. [3][4] *Virus* C.t $_{99.99}$ 6 mg.min/L at pH 7, 10°C, turbidity <2 NTU ~~45~~ C.$t_{99.99}$ 16 mg.min/L at pH 8, 10˚C and turbidity <2 NTU~~45~~ *Bacteria* C.$t_{99.99}$ <1 mg.min/L at pH 6-9, 10˚C-15˚C, and turbidity ≤1NTU. ~~45~~ For bacteria and viruses, a default of 15 mg.min/L is given as an acceptable value in the Guidelines (See also Information Sheet 1.3).
Chloramine	0	4	4	Published inactivation data. ~~56~~ *Virus* C.$t_{99.99}$ 3100 mg.min/L at pH 7, 10˚C, turbidity ≤2NTU~~45~~ C.$t_{99.99}$ 3970 mg.min/L at pH 8, 10˚C, turbidity ≤2NTU~~45~~ C.$t_{99.99}$ 6870 mg.min/L at pH 9, 10˚C, turbidity ≤2NTU~~45~~ *Bacteria* C.$t_{99.99}$ 360 mg.min/L at pH 8-9, ≥5˚C, turbidity ≤1NTU~~45~~ (See also Information Sheet 1.4).

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Chlorine dioxide	0	4	4	Published inactivation data and validation protocol.[6] *Virus* C.t $_{99}$ 5.6 mg.min/L at pH 6-9, 5°C, turbidity <1 NTU [4] *Bacteria* C.t$_{99}$ 0.4-0.75 mg.min/L at pH 6-9, 5˚C, and turbidity ≤1NTU.[4]
Ultraviolet light disinfection (UV)	4	4	4	Published inactivation data and validation protocol.[7] UV dose of 186 mJ/cm^2 can provide 4 log inactivation of viruses and 22 mJ/cm^2 can provide 4 log inactivation of protozoa and bacteria. (See also Information Sheet 1.7)
Ozone	4	4	4	Published inactivation data and validation protocol.[8] *Virus* C.t$_{99.99}$ ≥1.2 mg.min/L at pH 6-9, ≥5˚C, turbidity ≤1NTU *Protozoa*[5] C.t$_{99.99}$ ≥64 mg.min/L at pH 6-9, ≥5˚C, turbidity ≤1NTU *Bacteria*[5] C.t$_{99.99}$ ≥0.04 mg.min/L at pH 6-9, ≥5˚C, turbidity ≤1NTU[5] (See also Information Sheet 1.6)
Reverse osmosis (RO)	1.5-2 2.5-4	1.5-2 2.5-4	1.5-2 2.5-4	Published validation protocol.[9] Validated LRVs limited by sensitivity of operational monitoring. Based on on-line operational monitoring of EC or TOC. Based on on-line or off-line operational monitoring of sulfate or fluorescent dyes.

1 The data presented in this table for disinfectants assumes pathogens are freely suspended. If pathogens are contained within aggregates of other matter, including free-living protozoa commonly found in water systems, then for the fraction of internalised pathogens, the inactivation credits may need to be reduced by at least 2 logs (Folkins et al. 2020). LRVs can only be claimed if meeting requirements described in published material or by certification against validation protocols (as cited for individual processes) (see Chapter 9 and Victorian Department of Health 2013)

.~~2 USEPA 2006 (also see Turbidity Fact Sheet).~~

2 US EPA 2005.

3 Keegan et al. 2012 (see Information Sheet 1.3 “Disinfection with Chlorine”); WaterVal 2017a.

4 Concentration (C) and the corresponding disinfectant contact time (t) in minutes (C.t).

5 Keegan et al. 2012 (see Information Sheet 1.4 “Chloramines”).

(see Information Sheet 1.5 “Disinfection with chlorine dioxide”)

7 (see Information Sheet 1.7 “Disinfection with Ultraviolet Light”); WaterVal 2017b.

8 (see Information Sheet 1.6 “Disinfection with Ozone”); Waterval 2017c.

9 Waterval 2017d.

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APPENDIX B – Table 5.7 - Current and proposed tables

Current Table 5.7. Visit Table 5.7 Opportunistic pathogens of concern in Australian drinking water of the Guidelines.

5.5 Opportunistic pathogens

Opportunistic pathogens of concern in drinking water are summarised in Table 5.7. Naegleria fowleri, Burkholderia pseudomallei and Legionella pneumophila are particularly significant. Each of these has been linked to deaths associated with exposure to contaminated drinking water.

Additional information and references on the opportunistic pathogens listed in Table 5.7 are available in the relevant Fact Sheets in Part V.

Table 5.7 Opportunistic pathogens of concern in Australian drinking water

	Disease	Exposure pathway
Bacteria		
Aeromonas spp.	Systemic infections; wound infections;	Ingestion, dermal (open wound)
Burkholderia pseudomallei	Melioidosis	Dermal, ingestion, inhalation
Legionella spp.	Legionnaires' disease	Inhalation, aspiration
	Pontiac fever	
Mycobacteria	Pulmonary disease, skin ulcers, osteomyelitis and septic arthritis	Inhalation, dermal, ingestion
Pseudomonas aeruginosa	Skin infections	
Protozoa		
Naegleria fowleri	Primary Amoebic Encephalitis (PAM)	Intranasal
Acanthamoeba	Granulomatous amoebic encephalitis (GAE), amoebic keratitis	Ocular, dermal (open wound), inhalation

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Proposed amendments to Table 5.7

The most common ~~O~~opportunistic pathogens of concern in drinking water are summarised in Table 5.7. Naegleria fowleri, Burkholderia pseudomallei and Legionella pneumophila are particularly significant. Each of these has been linked to deaths associated with exposure to contaminated drinking water.

Additional information and references on the opportunistic pathogens listed in Table 5.7 are available in the relevant Fact Sheets in Part V.

Table 5.7 Opportunistic pathogens of concern in Australian drinking water

	Disease	Typical ~~E~~exposure pathway
Bacteria		
Aeromonas spp.	Systemic infections; wound infections;	Ingestion, dermal (open wound)
Burkholderia pseudomallei	Melioidosis	Dermal, ingestion, inhalation
Legionella spp.	Legionnaires' disease	Inhalation, aspiration
	Pontiac fever	
Non-tuberculous ~~M~~mycobacteria	Pulmonary disease, skin ulcers, osteomyelitis and septic arthritis	Inhalation, dermal, ingestion
Pseudomonas aeruginosa	Skin infections	Dermal (open wound), inhalation
Acinetobacter baumannii	Pneumonia, urinary tract infections, bloodstream infections (bacteremia), and skin and soft tissue infections	Dermal (open wound), inhalation
Protozoa		
Naegleria fowleri	Primary Amoebic Encephalitis (PAM)	Intranasal
Acanthamoeba spp.	Granulomatous amoebic encephalitis (GAE), amoebic keratitis	Ocular, dermal (open wound), inhalation
Vermamoeba vermiformis	Keratitis (eye infection)	Ocular

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Appendix C – Table 2.2 Correlations between HACCP and the Framework

Current Table 2.2. Visit Table 2.2 Correlations between HACCP and the Framework of the Guidelines.

HACCP	Framework for Management of Drinking Water Quality
1. Hazard identification and preventive measures	• Water supply system analysis, hazard identification and risk assessment (element 2) • Preventive measures and multiple barriers (element 3)
2. Critical control points	• Critical control points (element 3)
3. Critical limits	• Operational monitoring (element 4)
4. Monitoring system for each critical control point	• Operational monitoring (element 4)
5. Corrective actions	• Corrective action (elements 4 and 5)
6. Verification / validation	• Equipment capability and maintenance (element 4) • Drinking water quality monitoring, consumer satisfaction (element 5) • Validation of processes, design of equipment (element 9) • Audit of drinking water quality management (element 11)
7. Documentation and record keeping	• Management of documentation and records (element 10)

Proposed Table 2.2

HACCP	Framework for Management of Drinking Water Quality
1. Hazard identification and preventive measures	• Regulatory and formal requirements (element 1) • Water supply system analysis, hazard identification and risk assessment (element 2) • Preventive measures and multiple barriers (element 3) • Employee training (element 7)
2. Critical control points	• Critical control points (element 3)
3. Critical limits	• Operational monitoring (element 4)
4. Monitoring system for each critical control point	• Operational monitoring (element 4)
5. Corrective actions	• Corrective action (elements 4 and 5)
6. Verification / validation	• Equipment capability and maintenance (element 4) • Drinking water quality monitoring, consumer satisfaction (element 5) • Validation of processes, design of equipment (element 9) • Audit of drinking water quality management (element 11)
7. Documentation and record keeping	• Management of documentation and records (element 10) • Review by senior executive (element 12)

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Appendix D – Table 2.3 Correlations between ISO 9001 and the Framework

Current Table 2.3. Visit Table 2.3 Correlations between ISO 9001 and the Framework of the Guidelines.

Note: [*text in brackets*] has been included in Table 2.3 to improve accessibility in this document only. These edits will not be included in the proposed updated version of Table 2.3 within the *Australian Drinking Water Guidelines*.

ISO 9001	Framework for Management of Drinking Water Quality
Quality management system	*[Intentionally blank]*
General requirements	• See Section 2.5 Applying the Framework
Documentation requirements	• Management of documentation and records (element 10)
Management responsibility	*[Intentionally blank]*
Management commitment	• Drinking water quality policy, regulatory and formal requirements (element 1) • Review by senior executive, drinking water quality management improvement plan (element 12)
Customer focus	• Regulatory and formal requirements (element 1) • Community consultation (element 8)
Quality policy	• Drinking water quality policy (element 1)
Planning	• Regulatory and formal requirements (element 1) • Operational monitoring (element 4) • Drinking water quality monitoring (element 5)
Responsibility, authority and communication	• See Section 2.5 Applying the Framework
Management review	• Long-term evaluation of results, audit of drinking water quality management (element 11) • Review by senior executive, drinking water quality management improvement plan (element 12)
Resource management	*[Intentionally blank]*
Provision of resources; Drinking water quality management improvement plan (Element 12)	• Drinking water quality management improvement plan (element 12)
Human resources	• Employee awareness and involvement, employee training (element 7)
Infrastructure	• Equipment capability and maintenance (element 4) Design of equipment (element 9)

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ISO 9001	Framework for Management of Drinking Water Quality
Work environment	*[Intentionally blank]*
Product realisation	*[Intentionally blank]*
Planning of realisation processes	• Preventive measures and multiple barriers, critical control points (element 3)
Customer-related processes	• Community consultation, communication (element 8) • Regulatory and formal requirements (element 1)
Design and development	• Investigative studies and research monitoring, validation of processes, design of equipment (element 9)
Purchasing	• Materials and chemicals (element 4)
Production and service provision	• Operational procedures, operational monitoring, corrective action, equipment capability and maintenance (element 4) • Validation of processes (element 9)
Control of measuring and monitoring devices	• Equipment capability and maintenance (element 4)
Measurement, analysis and improvement	*[Intentionally blank]*
General	*[Intentionally blank]*
Monitoring and measurement	• Operational monitoring (element 4) • Drinking water quality monitoring, consumer satisfaction (element 5) • Audit of drinking water quality management (element 11)
Control of nonconforming product	• Corrective action (elements 4 and 5) • Incident and emergency response protocols (element 6) • Reporting (element 10)
Analysis of data	• Operational monitoring (element 4) • Short-term evaluation of results (element 5) • Long-term evaluation of results (element 11)
Improvement	• Review by senior executive, drinking water quality management improvement plan (element 12)

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Appendix D - Proposed Table 2.3

Note: [*text in brackets*] has been included in Table 2.3 to improve accessibility in this document only. These edits will not be included in the proposed updated version of Table 2.3 within the *Australian Drinking Water Guidelines*.

AS/NZS ISO 9001:2016	Framework for Management of Drinking Water Quality
Context of the organization (Clause 4)	*[Intentionally blank]*
Understanding the organisation and its context	• Drinking water quality policy (element 1) • Regulatory and formal requirements (element 1)
Understanding the needs and expectations of interested parties	• Engaging stakeholders (element 1) • Community consultation (element 8)
Determining the scope of the quality management system	• Drinking water quality policy (element 1) • Regulatory and formal requirements (element 1) • Hazard identification and risk assessment (element 2) • Community consultation (element 8)
Quality management system and its processes	*[Intentionally blank]*
Leadership (Clause 5)	*[Intentionally blank]*
Leadership and commitment	• Review by senior executive (element 12)
Establishing and communicating the quality policy	• Employee awareness and training (element 7) • Community involvement and awareness (element 8)
Organisational roles, responsibilities and authorities	*[Intentionally blank]*
Planning (Clause 6)	*[Intentionally blank]*
Actions to address risks and opportunities	• Water supply system analysis; assessment of water quality data; hazard identification and risk assessment (element 2)
Quality objectives and planning to achieve them	• Preventive measures and multiple barriers; critical control points (element 3)
Planning of changes	• Incident and emergency response protocols (element 6)
Support (Clause 7)	*[Intentionally blank]*
Resources	• Drinking water quality management improvement plan (element 12)
Awareness Competence	• Employee awareness and involvement; employee training (element 7)

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AS/NZS ISO 9001:2016	Framework for Management of Drinking Water Quality
Communication	• Communication for management of incidents and emergencies (element 6) • Communication for community involvement and awareness (element 7)
Documented information	• Documentation and reporting (element 10)
Operation (Clause 8)	*[Intentionally blank]*
Operational planning and control	• Operational procedures; operational monitoring; corrective action; equipment capability and maintenance; materials and chemicals (element 4)
Requirements for products and services	• Regulatory and formal requirement (element 1) • Community consultation (element 7)
Design and development of products and services	• Investigative studies and research monitoring; validation of processes; design of equipment (element 9)
Control of externally provided processes, products and services	• Drinking water quality monitoring (element 5) • Consumer satisfaction (element 5)
Production and service provision	• Operational procedures, operational monitoring, corrective action, equipment capability and maintenance (element 4)
Release of products and services	• Validation of processes (element 9) • Short-term evaluation of results (element 5)
Control of nonconforming outputs	• Corrective action (elements 4 and 5) • Incident and emergency response protocols (element 6) • Reporting (element 10)
Performance evaluation (Clause 9)	*[Intentionally blank]*
Monitoring, measurement, analysis and evaluation	• Operational monitoring (element 4) • Drinking water quality monitoring; short-term evaluation of results (element 5) • Validation of processes (element 9)
Internal audit	• Evaluation and audit (element 11)
Management review	• Review by senior executive (element 12)
Improvement (Clause 10)	*[Intentionally blank]*
General	*[Intentionally blank]*
Nonconformity and corrective action	• Corrective action (elements 4 and 5) • Incident and emergency response protocols (element 6)

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AS/NZS ISO 9001:2016	Framework for Management of Drinking Water Quality
Continual improvement	• Review by senior executive; drinking water quality management improvement plan (element 12)

Appendix E – Table 2.4 Comparison of features from various management frameworks

Current Table 2.4. Visit Table 2.4 Comparison of features from various management frameworks of the Guidelines.

Note: [*text in brackets*] has been included in Table 2.4 to improve accessibility in this document only. These edits will not be included in the proposed updated version of Table 2.4 within the *Australian Drinking Water Guidelines*.

Framework for Management of Drinking Water Quality	HACCP	ISO 9001 (2000)	AS/NZS 4360 (2004)
Commitment to drinking water quality management	[*not addressed*]	[*not addressed*]	[*not addressed*]
Drinking water quality policy	[*not addressed*]	+++ [*explicitly stated*]	+++ [*explicitly stated*]
Regulatory and formal requirements	+++ [*explicitly stated*]	+++ [*explicitly stated*]	[*not addressed*]
Engaging stakeholders	[*not addressed*]	[*not addressed*]	[*not addressed*]
Assessment of the drinking water supply system	[*not addressed*]	[*not addressed*]	[*not addressed*]
Water supply system analysis	+++ [*explicitly stated*]	[*not addressed*]	[*not addressed*]
Assessment of water quality data	[*not addressed*]	[*not addressed*]	[*not addressed*]
Hazard identification and risk assessment	+++ [*explicitly stated*]	[*not addressed*]	+++ [*explicitly stated*]
Preventive measures for drinking water quality management	[*not addressed*]	[*not addressed*]	[*not addressed*]
Preventive measures and multiple barriers	+++ [*explicitly stated*]	+ [implicit / interpreted]	+++ [*explicitly stated*]
Critical control points	+++ [*explicitly stated*]	[*not addressed*]	[*not addressed*]
Operational procedures and process control	[*not addressed*]	[*not addressed*]	[*not addressed*]
Operational procedures	+ [implicit / interpreted]	+++ [*explicitly stated*]	[*not addressed*]

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Framework for Management of Drinking Water Quality	HACCP	ISO 9001 (2000)	AS/NZS 4360 (2004)
Operational monitoring	+++ [*explicitly stated*]	+++ [*explicitly stated*]	[*not addressed*]
Corrective action	+++ [*explicitly stated*]	+++ [*explicitly stated*]	[*not addressed*]
Equipment capability and maintenance	+ [implicit / interpreted]	+++ [*explicitly stated*]	[*not addressed*]
Materials and chemicals	+ [implicit / interpreted]	+++ [*explicitly stated*]	[*not addressed*]
Verification of drinking water quality	[*not addressed*]	[*not addressed*]	[*not addressed*]
Drinking water quality monitoring	+++ [*explicitly stated*]	+++ [*explicitly stated*]	+++ [*explicitly stated*]
Consumer satisfaction	[*not addressed*]	+++ [*explicitly stated*]	[*not addressed*]
Short-term evaluation of results	[*not addressed*]	+++ [*explicitly stated*]	+ [implicit / interpreted]
Corrective action	+++ [*explicitly stated*]	+++ [*explicitly stated*]	[*not addressed*]
Management of incidents and emergencies	[*not addressed*]	[*not addressed*]	[*not addressed*]
Communication	[*not addressed*]	[*not addressed*]	[*not addressed*]
Incident and emergency response protocols	[*not addressed*]	[*not addressed*]	[*not addressed*]
Employee awareness and training	[*not addressed*]	[*not addressed*]	[*not addressed*]
Employee awareness and involvement	[*not addressed*]	+++ [*explicitly stated*]	[*not addressed*]
Employee training	+++ [*explicitly stated*]	+++ [*explicitly stated*]	[*not addressed*]
Community involvement and awareness	[*not addressed*]	[*not addressed*]	[*not addressed*]
Community consultation	[*not addressed*]	+++ [*explicitly stated*]	+++ [*explicitly stated*]
Communication	+ [implicit / interpreted]	+ [implicit / interpreted]	+++ [*explicitly stated*]
Research and development	[*not addressed*]	[*not addressed*]	[*not addressed*]
Investigative studies and research monitoring	[*not addressed*]	[*not addressed*]	[*not addressed*]

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Framework for Management of Drinking Water Quality	HACCP	ISO 9001 (2000)	AS/NZS 4360 (2004)
Validation of processes	+++ [*explicitly stated*]	+++ [*explicitly stated*]	[*not addressed*]
Design of equipment	[*not addressed*]	+++ [*explicitly stated*]	[*not addressed*]
Documentation and reporting	[*not addressed*]	[*not addressed*]	[*not addressed*]
Management of documentation and records	+++ [*explicitly stated*]	+++ [*explicitly stated*]	+++ [*explicitly stated*]
Reporting	[*not addressed*]	[*not addressed*]	+++ [*explicitly stated*]
Evaluation and audit	[*not addressed*]	[*not addressed*]	[*not addressed*]
Long-term evaluation of results	[*not addressed*]	+ [implicit / interpreted]	[*not addressed*]
Audit of drinking water quality management	+++ [*explicitly stated*]	+++ [*explicitly stated*]	+++ [*explicitly stated*]
Review and continual improvement	[*not addressed*]	[*not addressed*]	[*not addressed*]
Review by senior executive	+++ [*explicitly stated*]	+++ [*explicitly stated*]	+ [implicit / interpreted]
Drinking water quality management improvement plan	[*not addressed*]	+++ [*explicitly stated*]	[*not addressed*]

Notes:

+++ Aspect explicitly stated

+ Aspect not explicitly stated but interpreted to include

Appendix E - Proposed Table 2.4

Note: [*text in brackets*] has been included in Table 2.4 to improve accessibility in this document only. These edits will not be included in the proposed updated version of Table 2.4 within the *Australian Drinking Water Guidelines*.

Framework for Management of Drinking Water Quality	HACCP	AS/ NZS ISO 9001:2016	AS ISO 31000:2018
Commitment to drinking water quality management	[*not addressed*]	[*not addressed*]	[*not addressed*]

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Framework for Management of Drinking Water Quality	HACCP	AS/ NZS ISO 9001:2016	AS ISO 31000:2018
Drinking water quality policy	[*not addressed*]	+++ [*explicitly stated*]	+++ [*explicitly stated*]
Regulatory and formal requirements	+++ [*explicitly stated*]	+++ [*explicitly stated*]	+ [implicit / interpreted]
Engaging stakeholders	[*not addressed*]	+++ [*explicitly stated*]	+++ [*explicitly stated*]
Assessment of the drinking water supply system	[*not addressed*]	[*not addressed*]	[*not addressed*]
Water supply system analysis	+++ [*explicitly stated*]	+ [implicit / interpreted]	+ [implicit / interpreted]
Assessment of water quality data	[*not addressed*]	+ [implicit / interpreted]	+ [implicit / interpreted]
Hazard identification and risk assessment	+++ [*explicitly stated*]	+ [implicit / interpreted]	+++ [*explicitly stated*]
Preventive measures for drinking water quality management	[*not addressed*]	[*not addressed*]	[*not addressed*]
Preventive measures and multiple barriers	+++ [*explicitly stated*]	+ [implicit / interpreted]	+++ [*explicitly stated*]
Critical control points	+++ [*explicitly stated*]	+ [implicit / interpreted]	+ [implicit / interpreted]
Operational procedures and process control	[*not addressed*]	[*not addressed*]	[*not addressed*]
Operational procedures	+ [implicit / interpreted]	+++ [*explicitly stated*]	+ [implicit / interpreted]
Operational monitoring	+++ [*explicitly stated*]	+++ [*explicitly stated*]	+++ [*explicitly stated*]
Corrective action	+++ [*explicitly stated*]	+++ [*explicitly stated*]	+ [implicit / interpreted]

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Framework for Management of Drinking Water Quality	HACCP	AS/ NZS ISO 9001:2016	AS ISO 31000:2018
Equipment capability and maintenance	+ [implicit / interpreted]	+++ [*explicitly stated*]	+ [implicit / interpreted]
Materials and chemicals	+ [implicit / interpreted]	+++ [*explicitly stated*]	[*not addressed*]
Verification of drinking water quality	[*not addressed*]	[*not addressed*]	[*not addressed*]
Drinking water quality monitoring	+++ [*explicitly stated*]	+++ [*explicitly stated*]	+++ [*explicitly stated*]
Consumer satisfaction	[*not addressed*]	+++ [*explicitly stated*]	+ [implicit / interpreted]
Short-term evaluation of results	[*not addressed*]	+++ [*explicitly stated*]	+ [implicit / interpreted]
Corrective action	+++ [*explicitly stated*]	+++ [*explicitly stated*]	+ [implicit / interpreted]
Management of incidents and emergencies	[*not addressed*]	[*not addressed*]	[*not addressed*]
Communication	[*not addressed*]	+ [implicit / interpreted]	+ [implicit / interpreted]
Incident and emergency response protocols	[*not addressed*]	+ [implicit / interpreted]	+ [implicit / interpreted]
Employee awareness and training	[*not addressed*]	[*not addressed*]	[*not addressed*]
Employee awareness and involvement	[*not addressed*]	+++ [*explicitly stated*]	+++ [*explicitly stated*]
Employee training	+++ [*explicitly stated*]	+++ [*explicitly stated*]	+++ [*explicitly stated*]
Community involvement and awareness	[*not addressed*]	[*not addressed*]	[*not addressed*]
Community consultation	[*not addressed*]	+++ [*explicitly stated*]	+++ [*explicitly stated*]

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Framework for Management of Drinking Water Quality	HACCP	AS/ NZS ISO 9001:2016	AS ISO 31000:2018
Communication	+ [implicit / interpreted]	+ [implicit / interpreted]	+++ [*explicitly stated*]
Research and development	[*not addressed*]	[*not addressed*]	[*not addressed*]
Investigative studies and research monitoring	[*not addressed*]	[*not addressed*]	[*not addressed*]
Validation of processes	+++ [*explicitly stated*]	+++ [*explicitly stated*]	+ [implicit / interpreted]
Design of equipment	[*not addressed*]	+++ [*explicitly stated*]	[*not addressed*]
Documentation and reporting	[*not addressed*]	[*not addressed*]	[*not addressed*]
Management of documentation and records	+++ [*explicitly stated*]	+++ [*explicitly stated*]	+++ [*explicitly stated*]
Reporting	[*not addressed*]	+ [implicit / interpreted]	+++ [*explicitly stated*]
Evaluation and audit	[*not addressed*]	[*not addressed*]	[*not addressed*]
Long-term evaluation of results	[*not addressed*]	+ [implicit / interpreted]	+ [implicit / interpreted]
Audit of drinking water quality management	+++ [*explicitly stated*]	+++ [*explicitly stated*]	+++ [*explicitly stated*]
Review and continual improvement	[*not addressed*]	[*not addressed*]	[*not addressed*]
Review by senior executive	+++ [*explicitly stated*]	+++ [*explicitly stated*]	+++ [*explicitly stated*]
Drinking water quality management improvement plan	[*not addressed*]	+++ [*explicitly stated*]	+++ [*explicitly stated*]

Notes:

+++ Aspect explicitly stated

+ Aspect not explicitly stated but interpreted to include

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Appendix F – Box 8:3: Sample calculation for determining the lead recommended maximum impurity concentration in Alum

Current Box 8.3. Visit Box 8.3 Sample calculation for determining the lead recommended maximum impurity concentration in Alum of the Guidelines.

(p145-146 in PDF)

The following is a sample calculation for the derivation of a Recommended Maximum Impurity Concentration (RMIC) for lead in Alum and is based on the NHMRC guideline value for lead in drinking water of 0.01 mg/L. The maximum amount of lead (in mg/L) that may be added to drinking water through the use of alum is determined through the following three steps:

(1) Derivation of the maximum amount of lead that can be added to drinking water through Alum:

$$\frac{0.01}{10} = 0.001 \ mg/L$$

Where:

- 0.01 mg is the NHMRC guideline value for lead; and
- 10 is the percentage of the guideline value considered an acceptable source of contamination in the drinking water (a safety factor of 10 is considered a reasonable contribution by a given impurity in a water treatment chemical).
-

(2) Derivation of the amount of Alum that will contain 0.001 mg lead:

$$\frac{80 \text{ mg/L}}{0.43} = 186 \ mg$$

In the case of the maximum Alum dose of 80 mg/L(1) with a solution strength of 43 % w/w [$Al_2(SO_4)_3.14H_2O$];

Where:

- 80 mg/L is the dose of the drinking water treatment chemical (e.g. Alum); and
- 0.43 is the solution strength of the drinking water treatment chemical (e.g. Alum – 43%)

(3) Derivation of the RMIC for Alum at the plant:

$$\frac{1 \times 10^6}{186 \text{ mg}} \times 0.001 \text{ mg/L} = 5.4 \ mg.lead/kg \ of \ Alum \ solution$$

Where:

- 1×10^6 is the number of milligrams in a kilogram;
- 186 mg is the amount of Alum solution that will contain 0.001 mg of lead
- 0.001 mg/L is the maximum amount of lead per litre that can be added through the Alum dose

Footnote

(1) The dose of 80 mg/L alum is based on the water treatment plant being designed to regularly treat dirty water events under an enhanced coagulation mode. If the plant was designed to treat low turbidity water for particle removal only, the maximum alum dose may be as low as 10 mg/L which would give an RMIC of 43.2 mg/kg for lead at this plant

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Appendix F - Proposed Box 8.3

The following is a sample calculation for the derivation of a Recommended Maximum Impurity Concentration (RMIC) for lead in alum and is based on the NHMRC guideline value for lead in drinking water of 0.005 mg/L. The maximum amount of lead (in mg/L) that may be added to drinking water through the use of alum is determined through the following three steps:

(1) Derivation of the maximum amount of lead that can be added to drinking water through alum:

$$\frac{0.005}{10} = 0.0005 \text{ mg/L}$$

Where:

- 0.005 mg is the NHMRC guideline value for lead; and
- 10 is the percentage of the guideline value considered an acceptable source of contamination in the drinking water (a safety factor of 10 is considered a reasonable contribution by a given impurity in a water treatment chemical).

(2) Derivation of the amount of alum that will contain 0.0005 mg lead:

$$\frac{80 \text{ mg/L}}{0.47} = 170 \text{ mg}$$

In the case of the maximum alum dose of 80 mg/L(1) with a solution strength of 47 % w/w [$Al_2(SO_4)_3.14H_2O$];

Where:

- 80 mg/L is the dose of the drinking water treatment chemical (e.g. alum); and
- 0.43 is the solution strength of the drinking water treatment chemical (e.g. alum – 47%)

(3) Derivation of the RMIC for alum at the plant:

$$\frac{1 \times 10^6}{170 \text{ mg}} \times 0.0005 \text{ mg/L} = 2.9 \text{ mg.lead/kg of alum solution}$$

Where:

- 1×10^6 is the number of milligrams in a kilogram;
- 170 mg is the amount of alum solution that will contain 0.0005 mg of lead
- 0.0005 mg/L is the maximum amount of lead per litre that can be added through the alum dose

Footnote

(1) The dose of 80 mg/L alum is based on the water treatment plant being designed to regularly treat dirty water events under an enhanced coagulation mode. If the plant was designed to treat low turbidity water for particle removal only, the maximum alum dose may be as low as 10 mg/L which would give an RMIC of 23.5 mg/kg for lead at this plant.

Australian Government
National Health and Medical Research Council

NHMRC

APPENDIX G – Table 8.4 Recommended maximum impurity concentrations for selected drinking water treatment chemicals

Current Table 8.4. Visit Table 8.4 Recommended maximum impurity concentrations for selected drinking water treatment chemicals of the Guidelines.

	Impurity	Antimony	Arsenic	Barium	Cadmium	Chromium	Copper	Cyanide	Fluoride	Lead	Mercury	Nickel	Selenium	Silver
NHMRC Health-based Guideline Value (mg/L)		0.003	0.01	2	0.002	0.05	2	0.08	1.5	0.005	0.001	0.02	0.004	0.1
Treatment Chemical*	**Chemical Strength (%)**	**Example doses (mg/L)**												
Aluminium chlorohydrate	23	100 (as Al_2O_3)	0.7	2.3	161	0.5	11.5	460		345	2.3	0.2	4.6	2.3	
Aluminium sulfate (Alum)	47	20 (as $Al_2(SO_4)_3$)	7.1	23.6	1645	4.7	117.5	4700		3525	23.5	2.4	47	23.5	
Aluminium sulfate (Alum)	47	60 (as $Al_2(SO_4)_3$)	2.4	7.9	548	1.6	39.2	1567		1175	7.8	0.8	15.7	7.8	
Aluminium sulfate (Alum)	47	120 (as $Al_2(SO_4)_3$)	1.2	3.9	274	0.8	19.6	783		588	3.9	0.4	7.8	3.9	
Calcium hydroxide	99	30 (as $Ca(OH)_2$)		33.0	2310	6.6	165			4950	33	3.3	66	33	
Calcium hypochlorite	65	3 (as Cl_2)		217.0	15167	43.3	1083.3			32500	216.7	21.7	433.3	216.7	
Calcium oxide	10	500 (as CaO)		0.1	14	0.04	1			30	0.2	0.02	0.4	0.2	2
Chlorine	100	3 (as Cl_2)		333.0							333.3	33.3			
Copper sulfate	25.5	1 (as $CuSO_4.5H2O$)		255.0							255		510		
Ferric chloride	42	120 (as $FeCl_3$)	1.1	3.6		0.7	17.5	700	28		3.5	0.4	7	3.5	35
Ferric sulfate	20	100 (as $Fe_2(SO_4)_3$)	0.6	2.0		0.4	1	400	16		2	0.2	4	2	
Hydrochloric acid	33	5 (as HCl)	19.8			13.2	330				66		132	20	
Hydrofluorosilicic acid	16	1.5 (as F)		107.0		21.3					106.7				
Hydroxylated ferric sulfate	12.5	100	0.4	1.3		0.3	6.3	250	10		1.3	0.1	2.5	1.3	13
Polyaluminium chloride	10	100 (as Al_2O_3)	0.3	1.0	70	0.2	5	200		150	1	0.1	2.0	1	10
Potassium permanganate	99	1 (as $KMnO_4$)				198	4950					99			
Sodium fluoride	45	1.5 (as F)	90			60					300				
Sodium Fluorosilicate	60	1.5 (as F)	120			80									
Sodium hydroxide	50	10 (as NaOH)	15			10	250				50	5	100		
Sodium hypochlorite	12	3 (as Cl_2)				8						4	80		

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Sulfuric acid	98	5 (as H_2SO_4)	58.8	196.0	13720	39.2	980	39200		29400	196	19.6		196	

Appendix G - Proposed Table 8.4

		Impurity	Antimony	Arsenic	Barium	Cadmium	Chromium	Copper	Cyanide	Fluoride	Lead	Mercury	Nickel*	Selenium	Silver
NHMRC Health-based Guideline Value (mg/L)			0.003	0.01	2	0.002	0.05	2	0.08	1.5	0.005	0.001	0.02	0.004	0.1
Treatment Chemical*	**Chemical Strength (%)**	**Example doses (mg/L)**													
Aluminium chlorohydrate	23	100 (as Al_2O_3)	0.7	2.3	**460**	0.5	11.5	460		345	**1.15**	0.2	4.6	**0.92**	
Aluminium sulfate (Alum)	47	20 (as $Al_2(SO_4)_3$.**$14H_2O$**)	7.1	23.6	**4700**	4.7	117.5	4700		3525	**11.75**	2.4	47	**9.4**	
Aluminium sulfate (Alum)	47	60 (as $Al_2(SO_4)_3$.**$14H_2O$**)	2.4	7.9	**1567**	1.6	39.2	1567		1175	**3.9**	0.8	15.7	**3.1**	
Aluminium sulfate (Alum)	47	120 (as $Al_2(SO_4)_3$.**$14H_2O$**)	1.2	3.9	**783**	0.8	19.6	783		588	**2.0**	0.4	7.8	**1.6**	
Calcium hydroxide	99	30 (as $Ca(OH)_2$)		33.0	**6600**	6.6	165			4950	**16.5**	3.3	66	**13.2**	
Calcium hypochlorite	65	3 (as Cl_2)		217.0	**43333.3**	43.3	1083.3			32500	**108.4**	21.7	433.3	**86.7**	
Calcium oxide	10	500 (as CaO)		0.1	**40**	0.04	1			30	**0.1**	0.02	0.4	**0.08**	2
Chlorine	100	3 (as Cl_2)		333.0							**166.7**	33.3			
Copper sulfate	25.5	1 (as $CuSO_4$.5H2O)		255.0							**127.5**		510		
Ferric chloride	42	120 (as $FeCl_3$)	1.1	3.6		0.7	17.5	700	28		**1.75**	0.4	7	**1.4**	35
Ferric sulfate	20	100 (as $Fe_2(SO_4)_3$)	0.6	2.0		0.4	1	400	16		**1**	0.2	4	**0.8**	
Hydrochloric acid	33	5 (as HCl)	19.8			13.2	330				**33**		132	**26.4**	
Hydrofluorosilicic acid	16	1.5 (as F)		107.0		21.3					**53.4**				
Hydroxylated ferric sulfate	12.5	100	0.4	1.3		0.3	6.3	250	10		**0.7**	0.1	2.5	**0.5**	13
Polyaluminium chloride	10	100 (as Al_2O_3)	0.3	1.0	**200**	0.2	5	200		150	**0.5**	0.1	2.0	**0.4**	10
Potassium permanganate	99	1 (as $KMnO_4$)				198	4950					99			
Sodium fluoride	45	1.5 (as F)	90			60					**150**				
Sodium Fluorosilicate	60	1.5 (as F)	120			80									
Sodium hydroxide	50	10 (as NaOH)	15			10	250				**25**	5	100		
Sodium hypochlorite	12	3 (as Cl_2)				8						4	80		
Sulfuric acid	98	5 (as H_2SO_4)	58.8	196.0	**39200**	39.2	980	39200		29400	**98**	19.6		**78.4**	

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*note proposed updates to nickel contaminants as a result of proposed changes to the guideline value are outlined in a separate document for ammonia, nickel and chlorate.

APPENDIX H – Table A1.10 Example – potential critical control points and operational criteria

Current Table A1.10. Visit Table A1.10 Example — potential critical control points and operational criteria of the Guidelines.

Activity/process	Hazard(s)	Critical limit	Monitoring	Corrective action
Groundwater abstraction	Enteric bacteria, viruses and protozoa from septic and livestock waste; nitrates	Physical surety of bore and radius of protection zone. Absence of *E. coli.* NO_3 50 mg/L (as nitrate)	Weekly inspection and testing for presence of *E. coli*. 6-monthly monitoring of nitrate	Repair fault in bore Enforce protection zone
Catchment water reception at take off weir prior to reservoir	Higher levels of enteric bacteria, viruses and protozoa from septic and livestock waste following heavy rainfall	Set flow rate and turbidity limits at location upstream of weir	Continuous stream monitoring station	Divert flow away from reservoir intake
Reservoir mixing/ destratification	Cyanotoxins	6500 cells/mL *Target value: 1000 cells/mL*	Continuous monitoring of temperature and dissolved oxygen through the water column Regular sampling; increase frequency following detection of cyanobacteria or in summer	Dose reservoir with copper sulfate Improve efficiency of mixing Take reservoir out of service
Filtration	Enteric bacteria, viruses and protozoa	Combined filtered water turbidity < 0.5 NTU 95% of time. Maximum 5 NTU *Target value: < 0.3 NTU at all times*	Continuous online monitoring	Identify problem and take action (e.g. repair faulty operation) Increase coagulant dose Filter backwash
Primary disinfection and storage	Enteric bacteria, viruses and Giardia	Free chlorine residual > 1 mg/L	Continuous online monitoring and alarms	Increase chlorine dose

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Activity/process	Hazard(s)	Critical limit	Monitoring	Corrective action
		Detention >x (to set minimum C.t)*	with automatic feedback to chlorine dosing Flow not to exceed x ML per hr	Decrease flows to increase detention time Stop supply
Secondary disinfection	Enteric and free-living bacteria	Free chlorine residual >1 mg/L	Continuous online monitoring and alarms with automatic feedback to chlorine dosing	Increase chlorine dose Stop supply
Distribution of treated water	Enteric bacteria, viruses and protozoa Chemical contaminants	Minimum free chlorine residual of 0.2 mg/L at specified locations Positive pressure at specified locations	Continuous online monitoring Hydraulic pressure	Increase chlorine dose Identify and repair source of pressure loss

C.*t* = contact time; *E. coli* = *Escherichia coli*; NTU = nephelometric turbidity unit

*see Section A8 *Chlorination as an example of a critical control point*

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Proposed Table A1.10

Activity/process	Hazard(s)	Critical limit	Monitoring	Corrective action
Groundwater abstraction	Enteric bacteria, viruses and protozoa from septic and livestock waste; nitrates	Physical surety of bore and radius of protection zone. Absence of *E. coli.* NO_3 50 mg/L (as nitrate)	Weekly inspection and testing for presence of *E. coli*. 6-monthly monitoring of nitrate	Repair fault in bore Enforce protection zone
Catchment water reception at take off weir prior to reservoir	Higher levels of enteric bacteria, viruses and protozoa from septic and livestock waste following heavy rainfall	Set flow rate and turbidity limits at location upstream of weir	Continuous stream monitoring station	Divert flow away from reservoir intake
Reservoir mixing/ destratification	Cyanotoxins	6500 cells/mL *Target value: 1000 cells/mL*	Continuous monitoring of temperature and dissolved oxygen through the water column Regular sampling; increase frequency following detection of cyanobacteria or in summer	Dose reservoir with copper sulfate Improve efficiency of mixing Take reservoir out of service
Filtration	Enteric bacteria, viruses and protozoa	Individual filtered water turbidity should be < 0.2 NTU, and should not exceed 0.5 NTU at any time *Target value: < 0.5 NTU at all times*	Continuous online monitoring	Identify problem and take action (e.g. repair faulty operation) Increase coagulant dose Filter backwash
Primary disinfection and storage	Enteric bacteria, viruses and Giardia	Free chlorine residual > 1 mg/L to ≥0.5 mg/L Detention >x (to set minimum C.t)[a]	Continuous online monitoring and alarms with automatic feedback to chlorine dosing Flow not to exceed x ML per hr	Increase chlorine dose Decrease flows to increase detention time Stop supply

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Activity/process	Hazard(s)	Critical limit	Monitoring	Corrective action
Secondary disinfection	Enteric and free-living bacteria	Free chlorine residual >1 mg/L	Continuous online monitoring and alarms with automatic feedback to chlorine dosing	Increase chlorine dose Stop supply
Distribution of treated water	Enteric bacteria, viruses and protozoa Chemical contaminants	Minimum free chlorine residual of 0.2 mg/L at specified locations Positive pressure at specified locations	Continuous online monitoring Hydraulic pressure	Increase chlorine dose Identify and repair source of pressure loss

C.*t* = contact time; *E. coli* = *Escherichia coli*; NTU = nephelometric turbidity unit

[a] See Section A1.8 *Chlorination as an example of a critical control point*