Australian Government
National Health and Medical Research Council

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Proposed edits to Australian Drinking Water Guidelines – consequential edits related to lead replacements in plumbing products and manganese

Edit no.	Guidelines section	Page no.	Current Guideline text	Suggested Edit to Guideline text	Comments
1	Chapter 4 Section 4.2.2 Verification of drinking water quality	66	• At least daily testing of chlorine residuals should be carried out to check the effectiveness of the disinfection system. This can be done using a simple diethyl-phenylenediamine (DPD) colour comparator.	• At least daily testing of chlorine residuals should be carried out to check the effectiveness of the disinfection system. This can be done using a simple diethyl-phenylenediamine (DPD) colour comparator. Oxidised forms of manganese (e.g. permanganate) can interfere with the DPD method for determining chlorine residual, potentially resulting in an overestimation of the chlorine residual (see Information Sheet 1.4 on Chloramines).	New text added to clarify the interaction of manganese with the DPD test.
2	Chapter 5 Section 5.7.3 Deposits due to iron and manganese bacteria	98	Deposits due to iron and manganese bacteria	Edit heading to: Deposits due to iron- and manganese-oxidising bacteria	Text added to correct description of bacteria.
3	Chapter 5 Section 5.7.4 Corrosion problems due to iron and sulphur bacteria.	99	5.7.4 Corrosion problems due to iron and sulphur and bacteria.	Edit heading to: 5.7.4 Corrosion problems due to iron- and sulfur-metabolising bacteria.	Text added to correct description of bacteria and nomenclature of sulfur.

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4	Chapter 5 Section 5.7.4 Corrosion problems due to iron and sulphur bacteria.	99	Iron and sulphur bacteria contribute to the corrosion of iron and steel well pipes and drinking-water mains, with corrosion starting from either inside or outside. Microorganisms may cause corrosion by: • depleting dissolved oxygen • producing corrosive metabolites • producing sulphuric acid from sulphides or elemental sulphur participating in the electrochemical cathodic process.	Edit text to: Iron- and sulphur-metabolising bacteria contribute to the corrosion of iron and steel well pipes and drinking-water mains, with corrosion starting from either inside or outside. Microorganisms may cause corrosion by: • depleting dissolved oxygen • producing corrosive metabolites • producing sulphuric acid from sulphides or elemental sulphur participating in the electrochemical cathodic process.	Text added to correct description of bacteria.

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5	Chapter 6 Section 6.3 Chemical quality of drinking water	105	A number of chemicals, both organic and inorganic, including some pesticides, are of concern in drinking water from the health perspective because they are toxic to humans or are suspected of causing cancer. Some can also affect the aesthetic quality of water. The presence of chemical in drinking water may result from: • natural leaching from soils, rocks and mineral deposits into source waters; • land-use activities in catchments leading to exacerbation of natural processes such as mobilisation of salts; • run-off from agricultural operations within drinking water catchments; • biological processes including growth of cyanobacteria and algae in waterways and reservoirs; • contamination of source water by treated effluent discharge and other point sources within the catchment; • carry-over of small amounts of treatment chemicals; • addition of chemicals such as chlorine and fluoride; • corrosion and leaching of pipes and fittings.	A number of chemicals, both organic and inorganic, are of concern in drinking water from the health perspective because they are toxic to humans or are suspected of causing cancer. Some can also affect the aesthetic quality of water. The presence of chemicals in drinking water may result from: • natural leaching from soils, rocks and mineral deposits into source waters • land-use activities in catchments leading to exacerbation of natural processes such as mobilisation of salts • run-off from agricultural operations within drinking water catchments • biological processes including growth of cyanobacteria and algae in waterways and reservoirs • contamination of source water by treated effluent discharge and other point sources within the catchment • carry-over of small amounts of treatment chemicals • addition of chemicals such as chlorine and fluoride • generation of disinfection by-products due to interaction between organic chemicals in water and disinfectants like chlorine • corrosion and leaching of substances such as metals and metalloids from pipes, fittings and other plumbing products in contact with drinking water.	Text edited to remove superfluous text. Text added to provide additional relevant examples.

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6	Chapter 6 Section 6.3.1 Inorganic chemicals	105	Inorganic chemicals in drinking water usually occur as dissolved salts, principally carbonates, chlorides and sulfates, attached to suspended material such as colloids and clay particles, or as complexes with naturally occurring organic compounds. Unless otherwise stated, the guideline value refers to the total amount of the substance present, regardless of its form (e.g. in solution or attached to suspended matter).	Inorganic chemicals in drinking water include metals and metalloids, usually occurring as dissolved salts, principally carbonates, chlorides and sulfates, attached to suspended material such as colloids and clay particles, or as complexes with naturally occurring organic compounds. Metals of concern can be released from plumbing products, in both dissolved and particulate form, via chemical or biochemical reactions (e.g. microbially-influenced corrosion) within the water and through physical abrasion of surfaces. Unless otherwise stated, the guideline value refers to the total amount of the substance present, regardless of its form (i.e. both dissolved or particulate forms).	Text amended to describe leaching of metals from plumbing products.
7	Chapter 8 Section 8.8 Contaminants in drinking water treatment chemicals	140	-	Update information on contaminants in treatment chemicals based on any new guideline values as required.	Update to incorporate any new guideline values as required.

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8	Chapter 9 Section 9.1 Introduction	151	The *Framework for Drinking Water Quality Management* (the Framework), outlined in Chapters 2-4, is based on a preventive strategy that encompasses total system management from catchment to consumer to assure safe drinking water. A central aspect of this approach is the use of monitoring to confirm the effectiveness of the preventive measures and barriers to contamination, and to enhance understanding of system performance. This is achieved through the collection of data that increase understanding of the entire water supply system, including the hazards and risks that are present, the performance of treatment barriers, and the integrity of the distribution system.	The *Framework for Drinking Water Quality Management* (the Framework), outlined in Chapters 2-4, is based on a preventive strategy that encompasses total system management from catchment to consumer to assure safe drinking water. A central aspect of this approach is the use of monitoring to confirm the effectiveness of the preventive measures and barriers to contamination, and to enhance understanding of system performance. This is achieved through the collection of data that increase understanding of the entire water supply system, including the hazards and risks that are present, the performance of treatment barriers, and the integrity of the distribution system. Most of the monitoring information in this chapter relates to the operation of reticulated drinking water systems up to the point of supply (typically the water meter). However, water quality may be impacted beyond the point of supply, including through leaching of substances from plumbing products into drinking water, which may present a potential health risk to consumers at the tap (See Section 5.5 on Opportunistic pathogens; Section 9.6 on Water quality issues beyond the point of supply). Information Sheet 4.1 (Chemicals leaching from plumbing products) provides further information on leaching of substances from plumbing products, actions to reduce exposure and guidance on in-premise sampling.	Text amended to describe leaching of metals from plumbing products and cross reference relevant sections in the Guidelines.

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9	Chapter 9 Section 9.6 Water quality issues beyond the point of supply	172	Under most jurisdictional legislation and arrangements within Australia, the responsibility of water suppliers ends at the point of supply to the customer, typically the water meter. The primary responsibility for ensuring that water supplied beyond the water meter remains safe and aesthetically acceptable rests with various stakeholders including: • building and site owners or managers; • plumbing and building regulators; • plumbers; • plumbing material suppliers; • private individuals. Under the catchment-to-consumer tap preventive management framework promoted by these Guidelines, however, water quality should be managed up to the point of consumption, usually the customer tap, to account for water quality changes that may arise as a result of the internal plumbing arrangements on customer properties. This management may be achieved by liaison between the water supplier and the stakeholders listed above. Both microbial and chemical quality can deteriorate within buildings due to poor design and management of internal plumbing systems. While internal plumbing systems are largely outside of the control of water suppliers, incompatibility between the chemistry of drinking water as supplied and the quality and nature of internal plumbing	Under most jurisdictional legislation and arrangements within Australia, the responsibility of water suppliers ends at the point of supply to the customer, typically the water meter. The primary responsibility for ensuring that water supplied beyond the water meter remains safe and aesthetically acceptable rests with various stakeholders including: • building and site owners or managers • plumbing and building regulators • plumbers • manufacturers and suppliers of plumbing materials and products • private individuals • water suppliers. Under the catchment-to-consumer tap preventive management framework promoted by these Guidelines, however, water quality should be managed up to the point of consumption, usually the customer tap, to account for water quality changes that may arise as a result of the internal plumbing arrangements on customer properties. This management may be achieved by liaison between the water supplier and the stakeholders listed above. Both the microbial and chemical quality of drinking water can deteriorate within buildings due to poor design and management of internal plumbing systems. While internal plumbing systems are largely outside of the control of water suppliers (which can include water utilities, local councils or private water managers) and relevant health	Text amended to describe leaching of metals from plumbing products, clarify roles and responsibilities and cross reference relevant sections in the Guidelines.

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			and fittings can cause system-specific impacts, and it is reasonable to expect that water suppliers be aware of these issues. The two most common issues are: • plumbosolvency – that is, mobilisation of lead into solution from lead pipes and brass fittings (which may contain traces of lead), and the solder used to join pipes, as a result of the supply of plumbosolvent water. The issue of plumbosolvency is rare in Australia. Similar issues can arise with the corrosion of pipes and fittings containing copper (cupprosolvency), leading to "blue" water; • hardness – scaling of pipes, and of water elements in kettles and hot water services, resulting from the supply of very hard water. Other possible impacts include the following: • The supply of unbuffered desalinated water into areas not traditionally supplied with water of reduced salinity may exacerbate corrosion, particularly in hot water systems. • Microbial and chemical contamination can be associated with distribution systems in large buildings. This risk arises particularly where large volumes of water are stored for extended periods in on-site header tanks, or ingress of untreated water occurs through faults in the pipe network, or	authorities and/or drinking water regulators should be aware of broader system-specific impacts such as: • incompatibility between the chemistry of drinking water as supplied • in-premises water conditions including microbial water quality (see Section 5.5 on Opportunistic pathogens) • the quality and nature of internal plumbing and fittings. The two most common issues are: • Leaching of metals – metals of concern can be released from plumbing products, in both dissolved and particulate form, via chemical and biochemical reactions and through physical abrasion of surfaces. This is particularly evident when there have been periods of stagnation where drinking water is sitting in contact with plumbing products for extended periods of time (e.g. days to weeks). This is seen particularly in schools after lengthy holiday breaks, where water to drinking fountains/bubblers has remained stagnant in pipes. For example, children returning to school after a break have consumed water with elevated levels of copper (Scholz *et al.* 1995, Walker 1999, Brodlo *et al.* 2005). Long periods of stagnation may also occur within sections of a building's water distribution system, such as specific outlets that are not used frequently. Plumbing products that are deteriorated or	

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			there are cross-connections with non-drinking water supplies. • Drinking water that sits unused in pipe networks for extended periods of time may have elevated levels of metals. This is seen particularly in schools after lengthy holiday breaks, where water to drinking fountains has remained stagnant in pipes, with the result that children have consumed water with elevated levels of copper (Scholz et al. 1995, Walker 1999, Brodlo et al. 2005).	corroded are more prone to releasing metals to drinking water (enHealth 2021): – Lead may be introduced into drinking water from plumbing products. Lead-based drinking water pipes are quite rare in Australia, having not been installed since the 1930s, while lead-based solder was phased out of use in Australia in the 1990s, with Australian Standards limiting lead in solders to less than 0.1% within potable water distribution systems. However, brass plumbing products used in Australia up until 1 May 2026 are permitted to contain up to 4.5% lead (enHealth, 2021), and while Lead Free plumbing products that typically contain no more than 0.25% lead are available, they are currently not in common use. After 1 May 2026, only copper alloys containing no more than 0.25% lead are permitted for use in plumbing products in Australia (ABCB 2021, 2023). – Copper pipes are a common component of plumbing systems, and copper is also a major component of brass plumbing products, and as a result, copper may be present in drinking water. Elevated levels of copper in drinking water arising from corrosion of copper pipes used in plumbing systems can result in blue or green staining of plumbing fittings or basins. – Although reported less frequently, metals such as chromium, nickel, antimony and cadmium may also be present in drinking water due to their use in the manufacture of	

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				a variety of plumbing pipework and other products. • Elevated water hardness can cause scaling of pipes and ~~of~~ water elements in kettles and hot water services. Such deposits can have indirect impacts on water safety including ingress of contamination due to reducing flow rates, pressure and increasing the likelihood of the failure of backflow prevention measures. Further information about risks from chemicals leaching from plumbing products, actions to reduce exposure and in-premise water sampling is provided in Information Sheet 4.1 (Chemicals leaching from plumbing products). Other possible impacts on water quality past the point of supply include the following: • The supply of very soft water or unbuffered desalinated water into areas not traditionally supplied with water of reduced softness or salinity may exacerbate corrosion, particularly in hot water systems. • Microbial and chemical contamination can be associated with distribution systems in large buildings. This risk increases where water is stored for extended periods in on site header tanks, or ingress of untreated water occurs through faults in the pipe network, or there are cross-connections with non-drinking water supplies. See also Section 5.2 on Microorganisms in drinking water and Section 5.5 on Opportunistic pathogens.	

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10	Chapter 9 Section 9.6 Water quality issues beyond the point of supply *Role of building and site owners and managers and plumbing oversight agencies*	172	The *Trade Practices Act 1974* requires plumbing and fittings to be fit for purpose, and that purpose includes being fit for the safe conveyance, storage and use of water, of a chemistry as supplied within a particular area. Building and site owners, and managers and plumbing oversight agencies, are responsible for ensuring that the plumbing systems and fittings used within their areas of responsibility are fit to convey drinking water without leading to exceedances of water quality guidelines. In addition, these stakeholders should liaise with standards-setting bodies and water suppliers to ensure that the procedures for approving plumbing materials, fittings and systems are adequate, and that any products that are used comply with the requirements of *AS/NZS 4020:2005: Testing of Products for Use in Contact with Drinking Water.*	The *Competition and Consumer Act 2010* and related state and territory legislation requires plumbing and fittings to be fit for purpose, and that purpose includes being fit for the safe conveyance, storage and use of water, including its chemistry as supplied within a particular area. Building and site owners, and managers and plumbing oversight agencies, are responsible for ensuring that the plumbing systems and fittings used within their areas of responsibility are fit to convey drinking water without leading to exceedances of water quality guidelines. In addition, these stakeholders should liaise with standards-setting bodies and water suppliers to ensure that the procedures for approving plumbing products, fittings and systems are adequate, and that any products that are used comply with the requirements of *AS/NZS 4020: 2018: Testing of Products for Use in Contact with Drinking Water.* Building and site owners, and managers and plumbing regulatory agencies, should ensure that building plumbing systems are constructed and managed in a manner that is fit for purpose, taking into consideration factors such as water quality, temperature, rates of water turnover (to prevent stagnation). It is not unusual for new products (even if WaterMark certified) to initially leach chemicals into water in contact with them until such time as the products become conditioned, and a patina establishes on the fitting/fixture. A patina on metals and metallic alloys is a coating of various chemical compounds such as oxides, carbonates, sulfides, or sulfates formed on the wetted surface during exposure to water. This initial leaching	Text amended to describe leaching of metals from plumbing products, clarify roles and responsibilities and update references.

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				reduces over time and virtually ceases once the patina is established. It is not well established how long initial leaching period lasts, but it is widely accepted that this is largely affected by certain physical water parameters such as pH, hardness, alkalinity and temperature. Reducing potential exposure to the leaching of metals from plumbing products can be achieved at the tap by undertaking preventative flushing regimes as outlined in Information Sheet 4.1 (Chemicals leaching from plumbing products). To further minimise risk of leaching, all plumbing works undertaken in Australia must be conducted by a licensed plumber, and licensed plumbers must use products that are WaterMark Certified in applications involving drinking water. The WaterMark Certification Scheme is administered by the Australian Building Codes Board and more information is available from local councils or plumbing regulators.	
11	Chapter 9 Section 9.6 Water quality issues beyond the point of supply *Role of water suppliers*	173	Although Australian water suppliers are not responsible for the actions related to water quality management beyond the point of supply, they should be aware that the drinking water that they supply may interact with internal plumbing and cause unintended water quality issues (either aesthetic or health-related). The *Trade Practices Act 1974* requires water supplied by water suppliers to be fit for purpose, including the conveyance, storage and use of that water within approved plumbing assets, fittings and plumbed-in systems available in water supply areas. In effect, this means that water suppliers have obligations if they are aware of potential	Although Australian water suppliers are not responsible for the actions related to water quality management beyond the point of supply, they should be aware that the drinking water that they supply may interact with internal plumbing and cause unintended water quality issues (either aesthetic or health-related). The *Competition and Consumer Act 2010* and related state and territory legislation requires water supplied by water suppliers to be fit for purpose, including the conveyance, storage and use of that water within approved plumbing assets, fittings and plumbed-in systems available in water supply areas. In effect,	Text amended to describe leaching of metals from plumbing products and update references.

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			negative impacts of mains water on correctly designed and installed plumbing systems. Some recommended actions that water suppliers can take to minimise the risks associated with interaction of internal plumbing and supplied drinking water are: • Liaise with relevant state-based plumbing authorities to ensure that plumbers use only materials that meet the requirements of *AS/NZS 4020:2005: Testing of Products for Use in Contact with Drinking Water*. • Liaise with standards-setting bodies and plumbing regulators to ensure that the procedures for approving plumbing materials, fittings and systems are adequate to manage any short-, medium- and long-term risks associated with those materials, fittings and systems when carrying the water supplied in any particular supply area. • Prepare information for customers on water quality issues that may have an adverse impact on their internal plumbing. • Provide advice to customers with large reticulated networks on water quality issues that may arise from having stagnant water within their pipe networks. • Develop and disseminate information to schools, highlighting, in particular, issues related to stagnant water, and suggesting that drinking fountains and other water-	this means that water suppliers have obligations if they are aware of potential negative impacts of mains water on correctly designed and installed plumbing systems. Some recommended actions that water suppliers can take to minimise the risks associated with interaction of internal plumbing and supplied drinking water are: • Liaise with relevant state-based plumbing authorities to ensure that plumbers use only products that meet the requirements of *AS/NZS 4020: 2018: Testing of Products for Use in Contact with Drinking Water.* • Liaise with standards-setting bodies and plumbing regulators to ensure that the procedures for approving and testing plumbing products, fittings and systems are adequate to manage any short-, medium- and long-term risks associated with those products, fittings and systems when carrying the water supplied in any particular supply area. • Prepare information for customers on water quality issues that may have an adverse impact on their internal plumbing. • Provide advice to customers with large, reticulated networks on water quality issues that may arise from having stagnant water within their pipe networks. • Develop and disseminate information to schools, highlighting, issues related to stagnant water within pipe systems, and suggesting that	

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			using devices be flushed before school returns after holiday periods. • Ensure, wherever practicable, that each property is separately metered so that areas of low flow can be identified. • In liaison with building and site owners and managers and plumbing oversight agencies, consider undertaking investigative monitoring studies to examine the interactions of water as supplied with the plumbing and fittings used in the water supply area. Useful additional references on this issue include Rajaratnam et al. (2002), WHO and World Plumbing Council (2006), and WHO (2010).	drinking fountains/bubblers and other water-using devices be flushed before school returns after holiday periods. • Ensure, wherever practicable, that each property is separately metered so that areas of low flow can be identified. • In liaison with building and site owners, and managers and plumbing oversight agencies, consider undertaking investigative monitoring studies to examine the interactions of water as supplied with the plumbing and fittings used in the water supply area. Useful additional references on this issue include Rajaratnam *et al.* (2002), WHO and World Plumbing Council (2006), and WHO (2011).	
12	Chapter 9 Section 9.13 References	182	-	Add to the start of the existing reference list for Chapter 9: ABCB (2021). Lead in plumbing products in contact with drinking water. Final Regulation Impact Statement 2021. Australian Building Codes Board, July 2021. ABCB (2023). WaterMark Certification Scheme – Notice of Direction 2022/1.1: Acceptable copper alloys for the manufacture of Lead Free plumbing products. Australian Building Codes Board, May 2023.	Text amended to reference publications from the Australian Building Codes Board.

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13	Chapter 10 Monitoring for specific characteristics in drinking water Section 10.1 Introduction	185	-	Insert text at the end of section 10.1 i.e. after the 4th paragraph: Most of the information in this chapter relates to monitoring of distribution systems up to the point of supply (typically the water meter). However, water quality may be impacted beyond the point of supply through leaching of substances from plumbing products into drinking water, presenting a potential risk to health to consumers at the tap. The principles for evaluating short-term chemical and aesthetic water quality outlined in Tables 10.2 and 10.4 (Section 10.2.2) apply to in-premises water systems as well as distribution networks. Section 9.6 provides further information on water quality beyond the point of supply. Information Sheet 4.1 (Chemicals leaching from plumbing products) provides further information on leaching of substances from plumbing products, actions to reduce exposure and guidance on in-premise sampling.	Text amended to describe leaching of metals from plumbing products and cross reference relevant sections in the Guidelines.
14	Chapter 10 Table 10.6 Guideline values for physical and chemical characteristics	204–216	-	Update Table 10.6 with new health-based/aesthetic guidance values for bismuth, silicon, selenium, lead and manganese as required.	Update to include new health-based or aesthetic guideline values.

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15	Chapter 10 Table 10.6 Guideline values for physical and chemical characteristics	205, 207, 215	-	Include footnote 'f' reference in the entries for the following pesticides to align with other pesticide values included for information purposes only: • Carbophenothion • Chloroxuron • Thiophanate	Edit for consistency.
16	Chapter 10 Table 10.6 Guideline values for physical and chemical characteristics and Carbendazim fact sheet	205, 215	-	Ensure consistent terminology for both carbendazim and thiophanate-methyl across both Table 10.6 and fact sheet	Edit for consistency.
17	Chapter 10 Table 10.6 Guideline values for physical and chemical characteristics and Heptachlor fact sheet	210	-	Ensure consistent terminology for both heptachlor and heptachlor epoxide across both Table 10.6 and fact sheet	Edit for consistency.
18	Chapter 10 Table 10.6 Guideline values for physical and chemical characteristics and Lanthanum fact sheet	210	-	List lanthanum as La(III) to be consistent with chromium Cr(VI)	Edit for consistency.

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19	Chapter 10 Table 10.6 Guideline values for physical and chemical characteristics	215	-	Provide abbreviation for trichloroethylene (TCE) in Table 10.6 for consistency with other commonly abbreviated compounds	Edit for consistency.
20	Chapter 10 Table 10.6 Guideline values for physical and chemical characteristics	216	-	List all trihalomethanes included in the trihalomethanes fact sheet for consistency in Table 10.6	Edit for consistency.
21	Chapter 10 Table 10.6 Guideline values for physical and chemical characteristics	216	-	Correct xylene to xylenes to be consistent with the xylenes fact sheet.	Edit for consistency.
22	Part IV Disinfection with chlorine INFORMATION SHEET 1.3 Practical considerations	228	Advantages of chlorination include its common and long-standing use and the availability of reliable dosing and monitoring equipment. Reliable and robust field kits for measuring chlorine residuals within the distribution system are also available.	Advantages of chlorination include its common and long-standing use and the availability of reliable dosing and monitoring equipment. Reliable and robust field kits for measuring chlorine residuals within the distribution system are also available. Oxidised forms of manganese (e.g. permanganate) can interfere with the DPD method for determining chlorine residual, potentially resulting in an overestimation of the chlorine residual (see Information Sheet 1.4 on Chloramines).	Clarification that oxidised forms of manganese can interfere with the DPD test

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23	Part IV Disinfection Information Sheets **Chloramines** INFORMATION SHEET 1.4 Practical considerations	233	Chloramination has a long history of use and was introduced in Brisbane in 1935. Robust and reliable dosing and monitoring equipment is available. Reliable field kits for measuring residuals within the distribution system are also available; these kits generally measure concentrations of chloramines as total chlorine. There have been reports of false free chlorine readings with tablet-based methods (UWRAA 1990). The DPD-Ferrous titrimetric method is less prone to false readings (see monochloramine Fact Sheet).	Chloramination has a long history of use and was introduced in Brisbane in 1935. Robust and reliable dosing and monitoring equipment is available. Reliable field kits for measuring residuals within the distribution system are available; these kits generally measure concentrations of chloramines as total chlorine (DPD colorimetric method APH – A Method 4500-Cl Part F 2012). Oxidised forms of manganese (e.g. permanganate) can interfere with the DPD method for determining chlorine residual, potentially resulting in an overestimation of the chlorine residual. There have been reports of false free chlorine readings with tablet-based methods (UWRAA 1990). The DPD-Ferrous titrimetric method is less prone to false readings (see monochloramine Fact Sheet).	Clarification that oxidised forms of manganese can interfere with the DPD test
24	PHYSICAL AND CHEMICAL CHARACTERISTICS Chlorine Fact Sheet Measurement	512	The concentration of chlorine in drinking water can be determined by several methods including the amperometric titration method (APHA Method 4500-Cl Part D 2012), DPD ferrous titrimetric method (APHA Method 4500-Cl Part F 2012) and the DPD colorimetric method (APHA Method 4500-Cl Part G 2012). The methods are subject to interferences and vary in complexity, sensitivity, precision and accuracy. Water utilities should consider Standard Methods when selecting a method (APHA 2012). The chlorine concentration should be determined immediately after sampling as chlorine is not stable in water.	The concentration of chlorine in drinking water can be determined by several methods including the amperometric titration method (APHA Method 4500-Cl Part D 2012), DPD ferrous titrimetric method (APHA Method 4500-Cl Part F 2012) and the DPD colorimetric method (APHA Method 4500-Cl Part G 2012). The methods are subject to interferences (e.g., permanganate; see Information Sheet 1.4 on Chloramines) and vary in complexity, sensitivity, precision and accuracy. Water utilities should consider Standard Methods when selecting a method (APHA 2012). The chlorine concentration should be determined immediately after sampling as chlorine is not stable in water.	Clarification that oxidised forms of manganese can interfere with the DPD test

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25	PHYSICAL AND CHEMICAL CHARACTERISTICS Copper Fact Sheet Derivation of Guideline	552	In premises with a history of copper corrosion, water that has been in stagnant contact (6 hours or more) with copper pipes and fittings should not be used in the preparation of food or drink. Copper levels can be effectively reduced by flushing the taps for 1 minute	Insert cross reference to Section 9.6 and the new Information Sheet on chemicals leaching from plumbing products. Updated text in final paragraph: In premises with a history of copper corrosion, water that has been in stagnant contact (6 hours or more) with copper pipes and fittings should not be used in the preparation of food or drink. Copper levels can be effectively reduced by flushing the taps for 1 minute (see Section 9.6: Information Sheet 4.1).	Edit to insert cross-referencing
26	PHYSICAL AND CHEMICAL CHARACTERISTICS Monochloramine Fact Sheet Measurement	807	The concentration of monochloramine in drinking water can be determined by the DPD ferrous titrimetric method (APHA Method 4500-Cl Part F 2012) or by amperometric titration (APHA Method 4500-Cl Part D 2012). The limit of determination is typically 0.1 mg/L for the DPD method and can be lower for amperometric titration. Water utilities should refer to Standard Methods when selecting a method (APHA 2012).	The concentration of monochloramine in drinking water can be determined by the DPD ferrous titrimetric method (APHA Method 4500-Cl Part F 2012) or by amperometric titration (APHA Method 4500-Cl Part D 2012). The methods may be subject to interferences (e.g. permanganate; see Information Sheet 1.4 on Chloramines). The limit of determination is typically 0.1 mg/L for the DPD method and can be lower for amperometric titration. Water utilities should refer to Standard Methods when selecting a method (APHA 2012).	Clarification that oxidised forms of manganese can interfere with the DPD test

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27	PHYSICAL AND CHEMICAL CHARACTERISTICS Taste and Odour Fact Sheet Sources of Taste and Odour	969	Inorganic compounds are generally present in water in substantially higher concentrations than organic compounds. Taste thresholds for some commonly occurring inorganic ions are about 0.1 mg/L for manganese, 0.3 mg/L for iron, 3 mg/L for copper, 3 mg/L for zinc, 250 mg/L for chloride, and 250-500 mg/L for sulfate. Most of these ions have health guidelines at concentrations higher than their taste thresholds (except copper at 2 mg/L). In most cases the customer would reject the water for aesthetic reasons before it would be of health concern.	Inorganic compounds are generally present in water in substantially higher concentrations than organic compounds. Taste thresholds for some commonly occurring inorganic ions are about 0.05 mg/L for manganese, 0.3 mg/L for iron, 3 mg/L for copper, 3 mg/L for zinc, 250 mg/L for chloride, and 250-500 mg/L for sulfate. Some of these ions (e.g. manganese, sulfate) have health effects at concentrations higher than their taste thresholds (except copper at 2 mg/L). In most cases the customer would reject the water for aesthetic reasons before it would be of health concern.	Text updated to align with updated advice on manganese and existing advice in other fact sheets.
28	PHYSICAL AND CHEMICAL CHARACTERISTICS Temperature Fact Sheet	978	**General description** Temperature is primarily an aesthetic criterion for drinking water. Generally, cool water is more palatable than warm or cold water. In general, consumers will react to a change in water temperature. Complaints are most frequent when the temperature suddenly increases. The turbidity and colour of filtered water may be indirectly affected by temperature, as low water temperatures tend to decrease the efficiency of water treatment processes by, for instance, affecting floc formation rates and sedimentation efficiency. Chemical reaction rates increase with temperature, and this can lead to greater corrosion of pipes and fittings in closed	**General description** Temperature is primarily an aesthetic criterion for drinking water. Generally, cool water is more palatable than warm or cold water. In general, consumers will react to a change in water temperature. Complaints are most frequent when the temperature suddenly increases. The turbidity and colour of filtered water may be indirectly affected by temperature, as low water temperatures tend to decrease the efficiency of water treatment processes by, for instance, affecting floc formation rates and sedimentation efficiency. Chemical reaction rates increase with temperature, and this can lead to greater corrosion of pipes and fittings in closed systems resulting in elevated concentrations of leachates from plumbing	Text amended to describe leaching of metals from plumbing products and add cross-referencing to relevant sections in the Guidelines.

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			systems. Scale formation in hard waters will also be greater at higher temperatures. ... **Health considerations** The effectiveness of chlorine as a disinfectant is influenced by the temperature of the water being dosed. Generally higher temperatures result in more effective disinfection at a particular chlorine dose, but this may be counterbalanced by a more rapid loss of chlorine to the atmosphere (AWWA 1990). Chlorine reacts with organic matter in water to produce undesirable chlorinated organic by-products, and higher temperatures increase the rate of these reactions. Temperature can directly affect the growth and survival of microorganisms. In general, the survival time of infectious bacteria and parasites is reduced as the temperature of the contaminated water increases. *Naegleria fowleri*, which can cause amoebic meningitis, grows between 18°C and 46°C and is likely to occur in nondisinfected water supplies that reach 30°C seasonally. *Legionella pneumophila* (which causes Legionnaires' disease) and related bacteria are found in hot and cold water systems, with colonisation occurring in stagnant water at temperatures between 20°C and 45°C. Increased temperatures can also promote the growth of taste- and odour-	products (see Section 9.6). Scale formation in hard waters will also be greater at higher temperatures. ... **Health considerations** Warm and hot water in contact with plumbing products increases the rate of corrosion of metallic components. There is also a likelihood that non-metallic components can leach into water with elevated temperatures. A lot of materials used in plumbing products contain chemicals that have health-based guideline values. It has been shown that concentrations of these substances can approach and exceed their relevant health-based guideline values under certain conditions such as elevated temperatures within plumbing systems. Water used for consumption and food preparation should only be sourced from a cold water tap. Further information on leaching from plumbing products is available in Information Sheet 4.1 (Chemicals leaching from plumbing products). The effectiveness of chlorine as a disinfectant is influenced by the temperature of the water being dosed. Generally higher temperatures result in more effective disinfection at a particular chlorine dose, but this may be counterbalanced by a more rapid loss of chlorine to the atmosphere (AWWA 1990). Chlorine reacts with organic matter in water to produce undesirable chlorinated organic disinfection by-products, with higher temperatures	

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			producing organisms in lakes and impoundments, and in distribution systems.	increasing the rate of these reactions and their formation. Temperature can directly affect the growth and survival of microorganisms. In general, the survival time of infectious bacteria and parasites is reduced as the temperature of the contaminated water increases. *Naegleria fowleri*, which can cause amoebic meningitis, grows between 18°C and 46°C and is likely to occur in nondisinfected water supplies that reach 30°C seasonally. *Legionella pneumophila* (which causes Legionnaires' disease) and related bacteria are found in hot and cold water systems, with colonisation occurring in stagnant water at temperatures between 20°C and 45°C. Increased temperatures can also promote the growth of taste- and odour-producing organisms in lakes and impoundments, and in distribution systems.	
29	DRINKING WATER TREATMENT CHEMICALS – various fact sheets, e.g.: Calcium hypochlorite Chlorine Potassium permanganate Sodium hypochlorite	1072-1128	-	Update relevant sections with information about oxidised manganese interfering with assays for chlorine residuals using the indicator chemical DPD, where appropriate.	Clarification that oxidised forms of manganese can interfere with the DPD test

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30	General	Various	-	Update description of 'sulphate' and 'sulphide' to 'sulfate' and 'sulfide' throughout Guidelines consistent with IUPAC nomenclature, e.g.: • p93, p98 (x2) - Replace 'sulphate' with 'sulfate'. • p98, p99 - Replace 'sulphide' with 'sulfide' and 'sulphides' with 'sulfides'. • Monochloramine Fact Sheet, p807 - Replace 'sulphite' with 'sulfite'. • p114 - Replace 'disulphide' with 'disulfide'. • p97, p99 (x4) include Heading 5.7.4 (p99) and TOC (p viii) - Replace 'sulphur' with 'sulfur'. p99 - Replace 'sulphuric' with 'sulfuric'.	Updates to align with IUPAC nomenclature
31	Glossary	1191	-	DPD (diethyl-phenylenediamine) added	Clarify abbreviation used throughout Guidelines