Administrative Report

Chemical fact sheet reviews for the *Australian Drinking Water Guidelines*:

- Lead replacements in plumbing products (bismuth, silicon, selenium copper alloys)
- Lead
- Manganese

July 2024 - Public consultation draft

Contents

Administrative Report: Chemical fact sheet reviews for the *Australian Drinking Water Guidelines*

Summary

The National Health and Medical Research Council (NHMRC) has updated or developed guidance in the *Australian Drinking Water Guidelines* (the Guidelines) regarding several chemicals that have been prioritised for review.

The reviews have resulted in new or updated guidance in the Guidelines, including:

- a new information sheet on chemicals leaching from plumbing products
- two new fact sheets for bismuth and silicon
- updated fact sheets for lead, selenium and manganese
- consequential edits to align advice across the Guidelines.

This document summarises the guideline development process for these updates.

Background

NHMRC issues guidelines under section 7(1) of the *National Health and Medical Research Council Act 1992* (the Act). NHMRC maintains the Guidelines through a rolling review process to ensure they provide an up-to-date evidence-based framework for the management of drinking water quality.

The Guidelines form part of the National Water Quality Management Strategy, an Australian Government initiative in partnership with state and territory governments. The Guidelines are intended as a consistent source of authoritative guidance on drinking water quality management and allow states and territory governments to adapt the guidance to local needs.

Part V of the Guidelines contains fact sheets for over 200 chemicals that are typically present in Australian drinking water supplies. The fact sheets contain information on relevant aspects of the chemicals in drinking water, including but not limited to:

- health-related advice (e.g. a health-based guideline value and/or public health advice, health considerations, exposure information and risk summaries)
- supporting information (e.g. guidance on analytical measurements or sampling, water treatment and risk management options).

Since the current version of the *Australian Drinking Water Guidelines* (the Guidelines) was published in 2011, updates to specific sections of the Guidelines, including chemical fact sheets, have been undertaken as part of a 'rolling review' process. Suggestions for potential updates or the development of new advice are considered in response to new evidence, stakeholder needs and available resources. Updates are prioritised and delivered with advice from the Water Quality Advisory Committee (the Committee).

Review of prioritised fact sheets (including lead and selenium)

NHMRC has worked with previous terms of the Committee to prioritise work on a number of chemical fact sheets in the Guidelines. This was achieved by developing screening criteria that were used to prioritise the chemical fact sheets for review. The screening process along with consultation with the former enHealth Water Quality Working Group (now known as the Water Quality Expert Reference Panel) resulted in agreement on the chemicals prioritised for review.

The prioritised chemicals included: ammonia, antimony, cadmium, copper, cyanide, lead, nickel, nitrate and nitrite, selenium, sodium and uranium, bromate, chlorate, haloacetic acids, haloacetonitriles and trihalomethanes.

Contracted reviews (of existing guidance and guidelines only) for the prioritised chemicals commenced in May 2021. For both the lead and selenium reviews, it was found that although there were suitable candidate health-based guideline values for both chemicals that could be adopted/adapted to the Australian context, a substantial body of evidence had been published that had not been taken into consideration. Further review of the recent literature was recommended to support the update of the lead and selenium fact sheets.

Review of lead replacements in copper alloy plumbing products (bismuth, selenium and silicon)

In July 2021, the Australian Building Codes Board (ABCB) determined to limit the lead content of plumbing products in contact with drinking water to 0.25% (ABCB 2021, 2023) The Decision Regulation Impact Statement (RIS) recommended work be undertaken with health authorities on what limits should be placed, if any, on the use of lead substitutes. This change in regulation was proposed in response to building pressure from health agencies, including NHMRC, to improve public health outcomes in relation to lead in drinking water.

In preparation for these upcoming changes in regulation, NHMRC met with ABCB and enHealth in May 2021 to discuss the available data, timeframes and NHMRC processes required to develop public health advice for the Guidelines. Following this, enHealth requested that NHMRC prioritise a review of the health evidence for proposed lead replacements in plumbing products such as bismuth, selenium and silicon copper alloys and to develop public health advice for these and any future lead replacements that might appear on the market.

This report describes the process undertaken to review the evidence and develop public health advice for the chemicals that might be expected to leach from them into drinking water (bismuth, selenium and silicon). As part of this project, an extended review of the selenium and lead fact sheets was also undertaken to review the recent literature. Contracted reviews of the available evidence commenced in late 2022.

Review of manganese fact sheet

In mid-2023 public health authorities in the Northern Territory requested a review of the health-based guideline value for manganese in drinking water following reported exceedances of manganese in the drinking water of remote communities in the Northern Territory. Several international reviews had been published examining the potential toxicity of manganese in drinking water, and as a result lower drinking water guideline values had been implemented by other public health authorities (Health Canada 2019, WHO 2022). The review of manganese in drinking water was prioritised by the Committee and the enHealth Water Quality Expert Reference Panel at meetings held between July and December 2023. An evidence review of recent guidance/guidelines on manganese was undertaken by NHMRC in late 2023 – early 2024.

Development of guidance

Methodological framework

As part of a broader organisational effort to improve the processes used to develop NHMRC guidelines, NHMRC has designed a streamlined methodological framework (the Framework) to guide the rolling revision of chemical fact sheets in the Guidelines.

The Framework is intended to provide greater consistency and alignment with the 2016 *NHMRC Standards for Guidelines* and international best practice in evidence review methods and guideline development. It is also intended to:

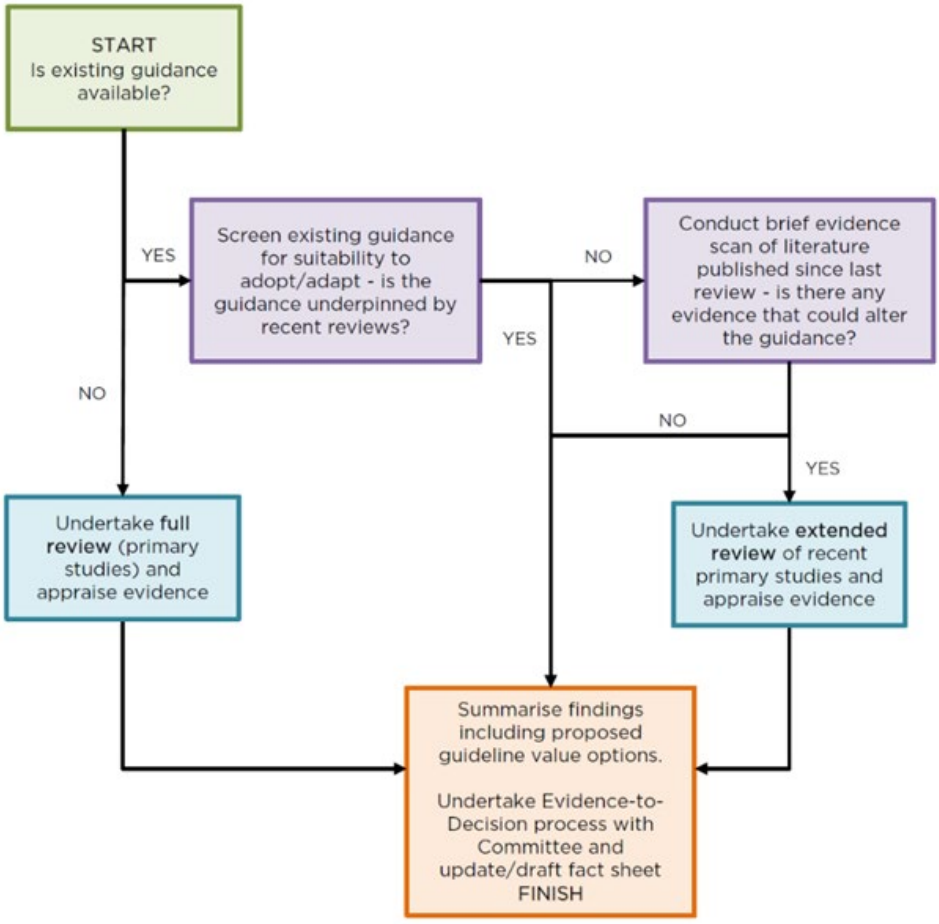
- make efficient use of limited project resources (e.g. funding, team and Committee capacity)
- make greater use of recent reviews undertaken by other jurisdictions and reduce duplication of effort
- minimise the timeframes required to undertake a chemical fact sheet review (depending on whether recent reviews are available)
- allow a more responsive approach to changes in international guidance
- allow more reviews to be undertaken in-house using templates and tools
- help inform future funding bids by identifying chemicals that may require additional funding for contracted evidence reviews.

The Framework provides the option to undertake different levels of review depending on the available evidence (see **Figure 1**). The Framework outlines a staged approach that preferences a transparent adopt/adapt process for evaluating existing health advice (such as international health-based guideline values) in the first instance instead of undertaking a more comprehensive review of primary studies. Other features of the Framework include:

- the option to undertake an evidence scan to check for emerging evidence of concern since the existing guideline was published (if it was not reviewed recently)
- the option to undertake reanalysis of key study findings from existing guidelines if appropriate and advised by the Committee
- the flexibility to customise the review process for each chemical using template research protocols for the different levels of review.

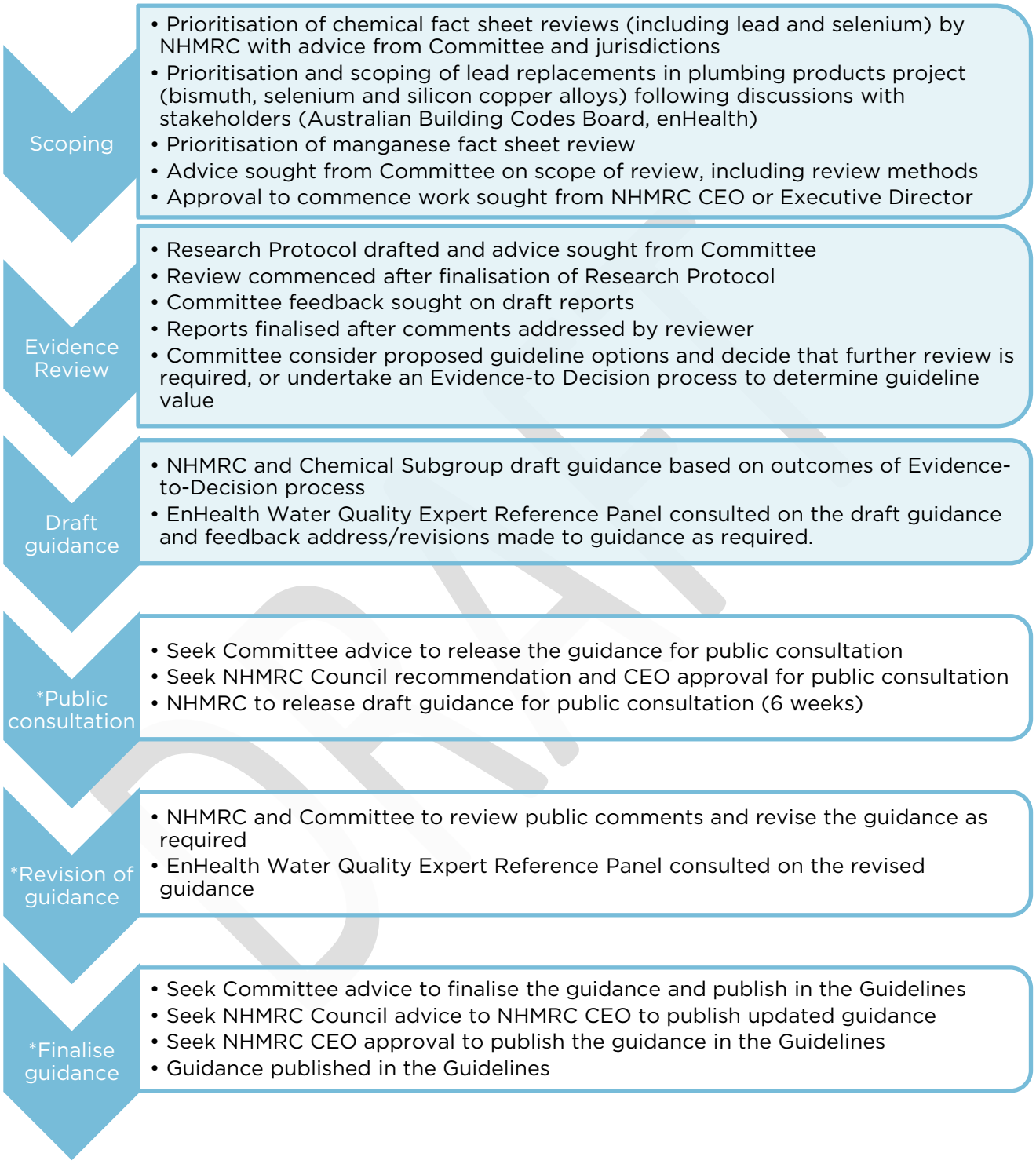
Existing guidance for a chemical may not always be available or appropriate to use for the Australian context. In these cases, a full review of recent primary studies is required and additional resources will be needed to undertake the review.

Figure 1: Simplified decision tree for undertaking evidence evaluation reviews using the Framework



Testing of the Framework as part of the rolling revision of the Guidelines has been underway since 2020, starting with prioritised chemical fact sheets (including lead and selenium). Key steps of the guidance development process for the Guidelines are summarised in **Figure 2**.

Figure 2: Overview of current rolling review process for updating/developing chemical fact sheets using Framework (*to be completed)



Contracted evidence reviews

SLR Consulting Australia was contracted through separate limited tender processes in 2021 and 2022 to:

- undertake a review of existing guidance/guidelines for a number of prioritised chemical fact sheets, including lead and selenium. The scope of this review was limited to searching, selecting and reviewing suitable existing guidance/guidelines for potential adoption/adaption in Australia.
- undertake a review of the evidence for selected lead replacements in plumbing products. This involved:
    - undertaking a full review of the primary literature for bismuth and silicon and their copper alloys as there were no existing drinking water guidelines for potential adoption/adaption.
    - undertaking an extended review for selenium and lead, as the first stage of review process did not find suitable guidance/guidelines to adopt/adapt in Australia without further review of the recent literature.

The reviewer applied the methodological framework as part of the evidence reviews by:

- customising a draft research protocol template provided by NHMRC for each chemical. The research protocol outlines the review scope and parameters for searching, selecting and appraising the evidence.
- confirming any amendments to the draft research protocol with the Committee at a meeting. The Committee confirmed the research questions and other technical details required for the reviews.
- finalising the research protocol (and any amendments) and seeking approval from NHMRC before commencing the review
- undertaking a review of evidence for each chemical as per the Framework (Figure 1), for example:
    - if recently published guidance/guidelines are available, assessing the methods used by the organisation/agency with an Assessment Tool provided by NHMRC that assesses administrative and technical criteria to determine if they are suitable to adopt/adapt
    - if undertaking a review of primary studies, assessing the study quality (risk of bias) using a risk of bias tool adapted from the Office of Health Assessment and Translation (OHAT 2019) and determining the level of certainty in the body of evidence.
- undertaking an evidence scan to support the development or update of supporting information in each chemical fact sheet
- derive candidate guideline options for each chemical in drinking water using Australian assumption values and uncertainty factors
- presenting the findings of the review in an Evidence Evaluation and Technical Report for Committee consideration.

The reviewer did not make recommendations for health-based guideline values but provided candidate guideline options for consideration by the Committee. These options were either based on:

- existing guidance/guidelines that were found suitable to adopt/adapt to the Australian context, with a critical discussion of the underlying key toxicological studies used by each agency to derive their guidance/guidelines
- key toxicological studies (animal or human) that the reviewer found to be of sufficient study quality to derive a health-based guideline value.

Further details on how each evidence review was undertaken is provided in the Research Protocols and Evidence Evaluation Reports for each chemical.

NHMRC review of manganese in drinking water

NHMRC staff conducted a targeted review of recently published guidance/guidelines on manganese to support an update to the chemical fact sheet in the Guidelines. The targeted review focused on recent manganese guidance published by the World Health Organization (2021, 2022), Health Canada (2019) and the European Food Safety Authority (2023).

The methodological framework was applied as part of the evidence reviews by:

- customising a draft NHMRC research protocol template for manganese. The research protocol outlined the review scope, research questions and parameters for searching, selecting and appraising the evidence.
- confirming any amendments to the draft research protocol with the Committee. The Committee confirmed the research questions and other technical details for the review.
- finalising the research protocol (and any amendments) and seeking approval from the Committee before commencing the review
- undertaking a review of evidence for manganese as per the Framework (Figure 1). As recently published guidance/guidelines were available, the methods used by the organisation/agency were assessed with an Assessment Tool developed internally that assesses administrative and technical criteria to determine if existing guidance/guidelines are suitable to adopt/adapt.
- undertaking an evidence scan to support the development or update of supporting information in the fact sheet
- derive candidate guideline options for manganese in drinking water using Australian assumption values and uncertainty factors as advised by the Committee
- presenting the findings of the review in an Evidence Evaluation Report for Committee consideration.

The review did not make recommendations for health-based or aesthetic guideline values but provided candidate guideline options for consideration by the Committee. These options were based on existing guidance/guidelines that were found suitable to adopt/adapt to the Australian context, with a critical discussion of the underlying key toxicological studies used by each agency to derive their guidance/guidelines.

Further details on how the evidence review was undertaken is provided in the Research Protocol and Evidence Evaluation Report for manganese.

Evidence-to-Decision process

Evidence reviews provide a comprehensive summary of the evidence but do not include recommendations (e.g. health-based guideline values). The term 'decision' is used to mean the resulting judgement of the evidence made by NHMRC and the Committee. NHMRC, with advice from the Committee, developed Evidence-to-Decision tables for each chemical based on the results of the Evidence Evaluation Reports and relevant criteria from existing Evidence to Decision frameworks (e.g. GRADE and WHO-INTEGRATE frameworks as outlined in Alonso-Coello *et al*. (2016) and Rehfuess *et al*. (2019)).

The draft Evidence-to-Decision tables (**Appendix A**) helped to inform Committee discussion and support transparent consideration of the findings from the evidence reviews undertaken by the reviewer (e.g. evidence profiles for candidate guideline values), along with public health considerations such as values and preferences, equity, feasibility and resource impacts.

Once the guideline options had been reviewed and considered by the Committee, NHMRC surveyed Members out of session on their preferred guideline options. Results of the survey were shared and discussed with the Committee during the December 2023 meeting, where consensus on guideline options were reached for each chemical. Guideline recommendations were updated as required on the advice of the Committee based on information received through feedback from targeted and public consultation. This process is summarised in **Table 1** below.

Table 1. Evidence to decision summary

December 2023 Committee meeting	Members agreed that: • no health-based guideline values should be set for bismuth and silicon or their copper alloys at this time, as health effects are expected to occur at levels much higher than concentrations expected in Australian drinking water. Members agreed that the derivation of the levels at which health effects are expected to occur (rounded to 10 mg/L for bismuth and 100 mg/L for silicon) should be provided in the fact sheet. • the health-based guideline value for selenium should be lowered from 0.01 mg/L to 0.004 mg/L based on health considerations. • the health-based guideline value for lead should be lowered from 0.01 mg/L to 0.005 mg/L based on health considerations. • health-based guideline values are reported to one significant figure for consistency with the existing Guidelines.
March 2024 Committee meeting	Members agreed that: • health-based guideline values for bismuth (10 mg/L) and silicon (100 mg/L) should be established based on health considerations. These changes to the guideline recommendations for bismuth and silicon were made to address feedback from members of the enHealth Water

	Quality Expert Reference Panel who raised concerns about potential confusion from end users. • the health-based guideline value for manganese should be lowered from 0.5 mg/L to 0.1 mg/L based on health considerations. • the aesthetic guideline value for manganese should be lowered from 0.1 mg/L to 0.05 mg/L based on providing safe clear, untainted water to consumers; managing the risks of manganese precipitates in the water distribution system and at the customer's tap; and readily achievable concentrations following water treatment. • health-based and aesthetic guideline values are reported to one significant figure for consistency with the existing Guidelines.

Drafting of guidance

The NHMRC Project Team drafted or updated fact sheets for each chemical based on the discussions with the Committee and the outcomes of the evidence-to-decision process. In addition, a number of consequential edits to other sections of the Guidelines were actioned to ensure consistency across the Guidelines and alignment with any proposed changes in health-based and/or aesthetic guideline values.

For the lead replacements in plumbing products review, an information sheet was also developed to provide general advice on managing risks from chemicals leaching from plumbing products. This included advice developed by enHealth in 2021 on preventative flushing regimes and in-premises sampling approaches (enHealth 2021).

The Chemical Subgroup reviewed the draft guidance and provided feedback before full Committee review and discussion at a committee meeting.

A timeline of the overall guideline development process is provided in **Table 2**.

Table 2. Timeline for chemical fact sheet reviews

Key guidance development steps	Timeframes
SLR Consulting Australia contracted to undertake review of existing guidance/guidelines for 11 prioritised chemicals (including selenium and lead fact sheets)	June 2021
Finalisation of research protocols for lead and selenium reviews with contracted reviewer (SLR Consulting Australia) and the Committee	June 2021
Stage 1 reviews (adopt/adapt existing guidance) of lead and selenium undertaken by reviewer	July 2021 – May 2022
Request from enHealth to review lead replacements in plumbing products	June 2021

NHMRC Chief Executive Officer (CEO) approval to commence review of potential health impacts of bismuth, selenium and silicon copper alloys on drinking water quality	October 2021
Committee consideration of finalised lead and selenium Stage 1 review reports and proposed approach to undertake review of bismuth, selenium and silicon copper alloys and continue review of selenium and lead fact sheets.	13 September 2022
SLR Consulting Australia contracted to undertake review of lead replacements in plumbing products (bismuth, selenium and silicon copper alloys, lead)	December 2022
Finalisation of research protocols for bismuth, selenium and silicon copper alloys review and extended review of lead with contracted reviewer (SLR Consulting Australia) and Committee feedback	February - March 2023
Full reviews of bismuth and silicon copper alloys, extended reviews for selenium and lead undertaken by reviewer. Draft reports reviewed by the Committee and comments addressed before final reports provided to NHMRC.	March – November 2023
Committee and enHealth Water Quality Expert Reference Panel support for prioritising a review of the health-based guideline value for manganese.	July - August 2023
Committee consideration of guideline options and evidence-to-decision process for bismuth, silicon, selenium and lead.	November – December 2023
Draft research protocol for manganese prepared and circulated to Committee for review and approval.	December - January 2024
Targeted review of recent guidance/guidelines on manganese undertaken by NHMRC. Draft evidence report reviewed by the Committee and comments addressed before report finalised.	December 2023– April 2024
NHMRC drafted guidance (lead and lead replacements in plumbing products) with advice from Chemical Subgroup	December 2023 – March 2024
Committee consideration of guideline options and evidence-to-decision process for manganese.	March 2024
Review of draft guidance (lead and lead replacements in plumbing products) by the Committee with subsequent revisions	March– April 2024
NHMRC drafted revised manganese chemical fact sheet with advice from the Chemical Subgroup for Committee review and approval.	April 2024

enHealth Water Quality Expert Reference Panel (WQERP) consultation on draft guidance (lead and lead replacements in plumbing products, **see Appendix B**) and subsequent revisions of guidance.	April 2024
enHealth Water Quality Expert Reference Panel consultation on draft manganese fact sheet (see **Appendix B**) and subsequent revisions of guidance.	May 2024
NHMRC Council advice to NHMRC CEO to release draft guidance for public consultation (including lead replacements in plumbing products, lead, manganese)	Early June 2024 (out of session)
NHMRC CEO approval to release draft guidance for public consultation	Early July 2024
Public consultation open (6 weeks)	*Mid-July – late August 2024
NHMRC and Committee review of submissions and revision of guidance as required	*August - September 2024
enHealth WQERP consultation on final guidance (see **Appendix B**)	*October 2024
Finalisation of guidance with advice from the Committee	*October 2024
Advice from NHMRC Council to publish final guidance in Guidelines	*November 2024
NHMRC CEO final approval to publish guidance in Guidelines	*December 2024
Publication of guidance in Guidelines	***January 2025**

*Anticipated dates (blue shading indicates tasks completed)
enHealth WQERP – Environmental Health Standing Committee Water Quality Expert Reference Panel

Water Quality Advisory Committee advice

The NHMRC Water Quality Advisory Committee (the Committee) provides expert advice to NHMRC on public health issues related to drinking water quality. The primary role of the Committee is the rolling review of the Guidelines.

Following the Framework, the Committee provided advice at several meetings during different stages of the review and guideline development processes, including advice on:

- the draft research protocols for each chemical review
- the draft evidence evaluation reports (initially through a subgroup of the Committee (the Chemical Subgroup) and then the full Committee)
- the candidate guideline options presented in the evidence review reports and evidence to decision tables
- the draft guidance documents (initially through the Chemical Subgroup and then full Committee)

- responses to address enHealth Water Quality Expert Reference Panel feedback and finalise the guidance for public consultation.

enHealth consultation

The enHealth Water Quality Expert Reference Panel provided expert feedback on the draft guidance. Panel membership included jurisdictional representatives working in the field of drinking water quality and public health who can provide feedback on the feasibility and accuracy of NHMRC advice.

The enHealth Water Quality Expert Reference Panel was formally consulted on the draft guidance on separate occasions in April - May 2024 prior to public consultation. A number of amendments to the draft guidance were made with advice from the Committee as a result of feedback provided.

Further details on the issues raised by the enHealth Water Quality Expert Reference Panel on the draft guidance and how these issues were addressed are provided in **Appendix B**.

Contributors

The Committee, in particular the Chemical Subgroup, led the development of the guidance. This work was undertaken over multiple terms of the Committee through 2021 to 2024. Committee membership during this period is outlined below.

Water Quality Advisory Committee

2018-2021 Water Quality Advisory Committee (2 January 2019 to 31 December 2021)

- Professor Fred Leusch (Chair), School of Environment and Science, Griffith University
- Ms Miranda Cumpston, Monash University and University of Newcastle
- Dr David Cunliffe, South Australian Department for Health and Wellbeing
- Mr Cameron Dalgleish, Tasmanian Department of Health
- Dr Dan Deere, Water Futures Pty Ltd
- Professor Cynthia Joll, Curtin Water Quality Research Centre, Curtin University
- Professor Stuart Khan, Water Research Centre, University of New South Wales
- Associate Professor Susan Petterson, Water & Health Pty Ltd / Griffith University
- Professor Craig Simmons, Australian Research Council / National Centre for Groundwater Research and Training, Flinders University
- Ms Carolyn Stanford (Consumer Rep), Stanford Marketing, Victoria
- Dr Katrina Wall, New South Wales Health Department
- Dr Nick Fletcher (Observer), Food Standards Australia New Zealand
- Ms Amy Lea (Observer), Department of Agriculture, Water and the Environment
- Mr Marcus Walters (Observer until 2020), Department of Agriculture, Water and the Environment

- Mr Adam Lovell (Observer), Water Services Association of Australia.

2022-2025 Water Quality Advisory Committee (29 April 2022 to 31 December 2025)

- Professor Nicholas Ashbolt (Chair), University of South Australia
- Dr David Cunliffe, South Australian Department for Health and Wellbeing
- Mr Cameron Dalgleish, Tasmanian Department of Health
- Professor Cynthia Joll, Curtin Water Quality Research Centre, Curtin University
- Professor Fred Leusch (from September 2023), School of Environment and Science, Griffith University
- Mr Peter Rogers, Water and public health expert
- Ms Nicola Slavin (from October 2022), Northern Territory Department of Health
- Dr Bala Vigneswaran, Water and public health expert
- Associate Professor Harriet Whiley, Flinders University
- Ms Sonia Colville (Observer until December 2023), Department of Climate Change, Energy, Environment and Water (DCCEEW)
- Ms Yulia Cuthbertson (Observer from December 2023), Department of Climate Change, Energy, Environment and Water (DCCEEW)
- Dr Kerry Nugent (Observer until December 2022), Australian Industrial Chemicals Introduction Scheme (AICIS)
- Dr Nobheetha Jayasekara (Observer from May 2023), Australian Industrial Chemicals Introduction Scheme (AICIS)
- Mr Laurence Wilson (Observer), National Indigenous Australians Agency (NIAA)
- Mr Adam Lovell (Observer until December 2023), Water Services Association of Australia.

Chemical Subgroup

Initial review of draft reports, drafting of guidance documents and subsequent revisions were undertaken by Committee members who were part of the Chemical Subgroup over the period from 2021 - 2024.

The following members of the 2018 – 2021 Water Quality Advisory Committee formed the Chemical Subgroup until 2021:

- Professor Stuart Khan (Subgroup Chair), Water Research Centre, University of New South Wales
- Professor Cynthia Joll, Curtin Water Quality Research Centre, Curtin University
- Professor Fred Leusch, School of Environment and Science, Griffith University
- Dr Nick Fletcher (Observer), Food Standards Australia New Zealand
- Dr David Cunliffe (from July 2020), South Australian Department for Health and Wellbeing.

The following members of the 2022-2025 Water Quality Advisory Committee formed the Chemical Subgroup until 2024:

- Professor Cynthia Joll (Subgroup Chair), Curtin Water Quality Research Centre, Curtin University
- Mr Cameron Dalgleish, Tasmanian Department of Health
- Professor Fred Leusch (from September 2023), School of Environment and Science, Griffith University.

NHMRC Project Team

This work was managed by the Water Team in the Public Health section of the Research Translation branch up until December 2023. The work has since been managed by the Environmental Health section, which now sits in the Research Quality and Advice branch.

Declarations of Interest

Appointees to committees of NHMRC are required to disclose their interests consistent with Section 42A of the Act, and instructions issued under sections 16A and 16B of the Public Governance, Performance and Accountability Rule 2014 (made under subsection 29(2) of the *Public Governance, Performance and Accountability Act 2013*). Prospective members were specifically asked to identify, to the best of their ability, interests including:

- financial interests: an interest must be declared when benefits or losses either in money or in-kind have occurred or may occur at a level that might reasonably be perceived to affect a person's judgement in relation to fair decisions about evidence and their participation in group decision-making
- other relationships: an interest must be declared when a strong position or prejudice or familial connection or other relationship held by a person could reasonably, or be perceived to, affect a person's judgement in relation to fair decisions about evidence and their participation in group decision-making including making an effort to arrive at a consensus
- affiliations to or associations with any organisations or activities that could reasonably be perceived to be an influence due to a competing interest, either for or against the issues being considered by the committee
- any other influences that might reasonably be considered likely to affect the expert judgement of the individual, or lead to the perception by others that the judgement of the individual is compromised.

Under the *Public Governance, Performance and Accountability Act 2013*, members have a responsibility to declare any interests to the whole committee, and members have a joint responsibility to decide on the management of any perceived or real conflict. No unmanageable conflicts were identified by the Committee or NHMRC.

Throughout the project, members were reminded of their obligation to consider any interest that may have arisen since the last meeting or with any particular agenda items. All disclosures and determinations about interests were recorded in the minutes of the Committee meetings. Members' relevant expertise and a summary of their disclosed interests were accessible on the

NHMRC website throughout the duration of the project. Declarations of interest were routinely raised at meetings of the Committee and the Chemical Subgroup during drafting of the guidance. Members of the Committee did not raise any concerns regarding these interests.

The relevant expertise of the Committee and a summary of their disclosed interests during the term of their membership is at Appendix C.

Project funding

This work was funded by NHMRC with contributions from the Commonwealth and the jurisdictions through the Australian Health Protection Principal Committee.

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Appendix A – Evidence to decision tables

DRAFT Evidence to decision table – Bismuth (CAS 7440-69-9)

The Evidence to Decision (EtD) table below is intended to capture key factors considered by NHMRC and the Water Quality Advisory Committee when comparing and deciding on potential guideline options. This is in alignment with NHMRC Standards for Guidelines. This table has been updated or amended to capture additional information provided through stakeholder feedback from targeted/public consultation and any changes to advice made as a result by NHMRC and the Water Quality Advisory Committee.

Criteria	OPTION 1: - Maintain status quo (no health-based guideline value for bismuth) - Provide information on level at which health effects might occur >10 mg/L	OPTION 2: - Establish new health-based guideline value for bismuth in drinking water of 10 mg/L
Example recommendation	*No guideline value is considered necessary for bismuth in drinking water, as concentrations are likely to be considerably lower than the level that can cause health effects.*	*Based on health considerations, the concentration of bismuth in drinking water should not exceed 10 mg/L.*
Health evidence profile	Bismuth is known to be toxic at high doses; however, there is currently no guideline value for bismuth in drinking water because typical levels usually found in drinking water supplies have not presented a health risk. It is noted that until recently plumbing materials containing bismuth were not in common use but this might change with the introduction of new regulations regarding the limit of lead in plumbing materials that come into contact with drinking water.	No existing health-based guidance/guideline values for bismuth for potential adoption/ adaption were identified. The dose response information in humans is insufficient for derivation of guidance/guideline values for bismuth. A review of primary animal studies identified a single study of sufficient quality that could be considered for potential guideline derivation. Sano *et al*. (2005) conducted an acute and repeat dose oral (gavage) toxicity study using bismuth metal (pure metal) in rats

	Relevant information from the evidence review in Option 2 will be used to develop a fact sheet, including health information and a concentration at which health effects might occur if exceeded.	(this is likely the most relevant form of bismuth reminiscent of the type of bismuth exposure that might occur to bismuth alloys – see Section 5.2.2 of the Bismuth Evidence Evaluation Report). The study was well conducted and included all standardised endpoints which are typically investigated in such studies. The repeat dose study established a 28-day No Observed Adverse Effect Level (NOAEL) as the highest dose tested (i.e. 1,000 mg Bi/kg bw/d in female/male rats). On its own, the study is judged to not have a serious risk of bias based on the majority of key domains having a low risk of bias. Adaption of the identified NOAEL of 1,000 mg Bi/kg bw/d using default assumptions and applying a composite uncertainty factor of 300 (see Section 5.2.2 of Bismuth Evidence Evaluation report) would result in a health-based guideline value of 10 mg/L (rounded to 1 significant figure).
Exposure profile	Insufficient leaching data from plumbing materials were identified.	
Health benefits vs harms	Given the lack of leaching data it is uncertain whether this option will be protective of public health or not. Publication of a fact sheet including uncertainties around actual risks may help build awareness and drive health research in this area.	This guideline option will be protective of public health in the absence of leaching data while ensuring testing of products before they enter the market. It will also allow generation of datasets to help clarify the level of risk to consumers.
Values and preferences (consumers, communities)	To NHMRC's knowledge, consumers have not previously raised any concerns about bismuth in drinking water supplies. It is noted that this might change once it is known that there are new 'lead-free' plumbing materials on the market. It is reasonable to assume that consumers and communities would expect that: • supplied drinking water is safe to drink at the tap, regardless of whether leaching of chemicals from plumbing occurs beyond the point of supply or not	

	• that new/emerging risks to public health from drinking water are considered by NHMRC and appropriate action is taken depending on the risks to public health and that all guideline options under consideration will be protective of public health • plumbing materials available for sale in Australia (particularly 'lead-free' WaterMark products) will have been tested rigorously and found to be compliant with Australian standards, and will be safe to install and use under typical conditions • that the materials used to replace lead in plumbing will not leach chemicals into drinking water that might cause harm to public health.	
Acceptability (other key stakeholders)	Given that the health evidence will have been reviewed and a justification for not setting a guideline value published in a fact sheet, this guideline option will provide some certainty that bismuth copper alloys are safe for use as potential lead replacements in plumbing materials for: • health regulators and/or drinking water authorities • water and construction/plumbing and manufacturing industries • consumers. However, given as there is uncertainty about exposure as there is insufficient leaching data available, it might be unacceptable to some stakeholders to not set a guideline value that might protect health in the absence of exposure data. A health-based drinking water guideline value for bismuth has not been established by similar international agencies, which may support consumer acceptability for this option.	This guideline option will provide the greatest confidence in bismuth copper alloys as safe lead replacements in plumbing materials for: • health regulators and/or drinking water authorities • water and construction/plumbing and manufacturing industries • consumers. Potential impacts of this guideline option on stakeholders: • increased (and potentially unnecessary) monitoring requirements may be unacceptable to water providers given that levels of bismuth in typical drinking water supplies in Australia have not previously presented any health risks • increased regulatory burden for health regulators and/or drinking water authorities as a result of increasing monitoring requirements may be unacceptable; however, this option will be most protective of public health in the absence of leachability data so might be more acceptable from the health protection perspective. • testing requirements for industry will increase as a new health-based guideline value will be embedded in the

		testing requirements for AS/NZS 4020; however, this might be balanced by the sector having greater confidence in product safety.
Feasibility	This guideline option is feasible as no changes to current practice are required. If industry adopt a potential product testing limit for bismuth of 12 mg/L, this would be achievable with existing treatment technologies and readily measurable with current commercial analytical techniques.	This guideline option is technically feasible. The concentration of the candidate health-based guideline value of 10 mg/L would be achievable with existing treatment technologies and readily measurable with current commercial analytical techniques. If industry implement a product testing limit for bismuth of 10 mg/L, this would be achievable with existing treatment technologies and readily measurable with current commercial analytical techniques.
Health equity impacts	Lead leaching has been an issue in communities with ageing infrastructure and plumbing in existing houses and it may also be an issue in the early years of occupancy of new houses that have used currently available fittings. Replacement of ageing/lead plumbing with 'lead-free' options will be required in all new builds from May 2026 and is intended to improve health outcomes for the Australian population by minimising exposure to lead.	Lead leaching has been an issue in communities with ageing infrastructure and plumbing in existing houses and it may also be an issue in the early years of occupancy of new houses that have used currently available fittings. Replacement of ageing/lead plumbing with 'lead-free' options will be required in all new builds from May 2026 and is intended to improve health outcomes for the Australian population by minimising exposure to lead. This option will be most conservative and protective of public health for the general population.
Resource impacts	None.	Resources will be required to monitor and test for bismuth in water supplies and in plumbing materials if a new guideline value for bismuth is introduced in the Guidelines. In addition: • increased costs of testing for bismuth by water providers (including those who already have limited resources),

		noting that it is unlikely that water treatment will be required given typical low levels observed in Australian source waters • costs to water providers and manufacturers might flow on to consumers • there may be resource impacts on industry testing of new plumbing materials for bismuth leaching • it is unclear what the resource impacts on the implementation of a new guideline value on AZ/NZS 4020 would be, including the impacts on the WaterMark certification process for plumbing products.
Decision	• In December 2023, Members agreed that no health-based guideline value should be set for bismuth or bismuth copper alloys, as health effects are expected to occur at levels much higher than concentrations expected in Australian drinking water supplies. Members agreed that the derivation of the levels at which health effects are expected to occur for bismuth (rounded to 10 mg/L) should be provided in the fact sheet. Members also agreed that the health-based guideline value should be reported to one significant figure for consistency with rounding conventions outlined in the Guidelines. • In March 2024, Members agreed to establish a health-based guideline value for bismuth of 10 mg/L based on health considerations. This change to the guideline recommendation for bismuth was made to address feedback from members of the enHealth Water Quality Expert Reference Panel who raised concerns about potential confusion from end users.	

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DRAFT Evidence to decision table – Silicon (CAS 7440-21-3)

The Evidence to Decision (EtD) table below is intended to capture key factors considered by NHMRC and the Water Quality Advisory Committee when comparing and deciding on potential guideline options. This is in alignment with NHMRC Standards for Guidelines. This table has been updated or amended to capture additional information provided through stakeholder feedback from targeted/public consultation and any changes to advice made as a result by NHMRC and the Water Quality Advisory Committee.

Criteria	OPTION 1: - Maintain status quo (no health-based guideline value for silicon) - Provide information on health effects that might occur >100 mg/L	OPTION 2: - Establish new health-based guideline value for silicon in drinking water of 100 mg/L
Draft recommendation	*No guideline value is considered necessary for silicon in drinking water, as concentrations are likely to be considerably lower than the level that can cause health effects.*	*Based on health considerations, the concentration of silicon in drinking water should not exceed 100 mg/L.*
Health evidence profile	There is currently no advice on silicon copper alloys or silicon in the Guidelines, presumably because typical levels usually found in drinking water supplies have not as yet presented a health risk. It is noted that until recently plumbing materials containing silicon copper alloys were not in common use but this might change with the introduction of new regulations regarding the limit of lead in plumbing materials that come into contact with drinking water. There is a silica (SiO_2) fact sheet and an aesthetic guideline value of 80 mg/L based on scale build up on surfaces (e.g.	One existing health-based guidance value for silicon for potential adoption/ adaption was identified (EVM 2003). The identified guidance value was based on a total diet study in rats by Takizawa *et al*. 1988 that found no adverse effects in rats fed silica in the diet over a 2-year period. This study was found to have moderate certainty in the study findings. Adaption of the NOAEL from Takizawa *et al*. 1998 of 11.75 mg silicon/kg/day was used as the point of departure in the potential guideline derivation resulting in a potential guideline value for silicon of 100 mg/L (rounded to 1 significant figure from 120 mg/L). The relative source contribution was adjusted from 0.1 to 0.3 based on estimated daily intake in European diets. A composite uncertainty factor of 100 adjusted

	glass). No health guideline has been set for silica as there are currently no data linking silica to adverse health outcomes. Relevant information from the evidence review in Option 2 will be used to develop a fact sheet, including health information and a concentration at which health effects might occur if exceeded.	for extrapolation from animal to humans (x10), and for human variability (x10) was applied.
Exposure profile	Insufficient leaching data from plumbing materials were identified.	
Health benefits vs harms	Given the lack of leaching data it is uncertain whether this guideline option will be protective of public health or not. Publication of a fact sheet including uncertainties around actual risks may help build awareness and drive health research in this area.	This guideline option will be protective of public health in the absence of leaching data while ensuring testing of products before they enter the market. It will also allow generation of datasets to help clarify the level of risk to consumers.
Values and preferences (consumers, communities)	It is reasonable to assume that consumers and communities would expect that: • supplied drinking water is safe to drink at the tap, regardless of whether leaching of chemicals from plumbing occurs beyond the point of supply or not • that new/emerging risks to public health from drinking water are considered by NHMRC and appropriate action is taken depending on the risks to public health and that all guideline options under consideration will be protective of public health • plumbing materials available for sale in Australia (particularly 'lead-free' WaterMark products) will have been tested rigorously and found to be compliant with Australian standards, and will be safe to install and use under typical conditions • that the materials used to replace lead in plumbing will not leach chemicals into drinking water that might cause harm to public health.	
Acceptability (other key stakeholders)	Given that the health evidence will have been reviewed and a justification for not setting a guideline value published in a fact sheet, this guideline option will provide	This guideline option will provide the greatest confidence in silicon copper alloys as safe lead replacements in plumbing materials for: • health regulators and/or drinking water authorities

	some certainty that silicon copper alloys are safe for use as potential lead replacements in plumbing materials for: • health regulators and/or drinking water authorities • water and construction/plumbing and manufacturing industries • consumers. However, given as there is uncertainty about exposure as there is insufficient leaching data available, it might be unacceptable to some stakeholders to not set a guideline value that might protect health in the absence of exposure data. A health-based drinking water guideline value for silicon has not been established by similar international agencies, which may support consumer acceptability for this option.	• water and construction/plumbing and manufacturing industries • consumers. Potential impacts of this guideline option on stakeholders: • initial increased (and potentially unnecessary) monitoring requirements may be unacceptable to water providers given that levels of silicon in typical drinking water supplies in Australia have not previously presented any health risks • increased regulatory burden for health regulators and/or drinking water authorities as a result of increasing monitoring requirements may be unacceptable; however, this option will be most protective of public health in the absence of leachability data so might be more acceptable from the health protection perspective. • testing requirements for industry will increase as a new health-based guideline value will be embedded in the testing requirements for AS/NZS 4020; however, this might be balanced by greater confidence in product safety.
Feasibility	This guideline option is feasible as no changes to current practice are required. If industry adopt a potential product testing limit for silicon of 100 mg/L, this would be achievable with existing treatment technologies and readily measurable with current commercial analytical techniques.	This guideline option is technically feasible. The concentration of the candidate health-based guideline value of 100 mg/L would be achievable with existing treatment technologies and readily measurable with current commercial analytical techniques. If industry implement a product testing limit for silicon of 100 mg/L, this would be achievable with existing treatment technologies and readily measurable with current commercial analytical techniques.
Health equity impacts	Lead leaching has been an issue in communities with ageing infrastructure and plumbing in existing houses and it may also be an issue in the early years of occupancy of new houses that have used currently available fittings.	Lead leaching has been an issue in communities with ageing infrastructure and plumbing in existing houses and it may also be an issue in the early years of occupancy of new houses that have used currently available fittings.

	Replacement of ageing/lead plumbing with 'lead-free' options will be required in all new builds from May 2026 and is intended to improve health outcomes for the Australian population by minimising exposure to lead.	Replacement of ageing/lead plumbing with 'lead-free' options will be required in all new builds from May 2026 and is intended to improve health outcomes for the Australian population by minimising exposure to lead. This option will be most conservative and protective of public health for the general population.
Resource impacts	None.	Resources will be required to monitor and test for silicon in water supplies and in plumbing materials if a new guideline value for silicon is introduced in the Guidelines. In addition: • increased costs of testing for silicon by water providers (including those who already have limited resources), noting that it is unlikely that water treatment will be required given typical low levels observed in Australian source waters • costs to water providers and manufacturers might flow on to consumers • there may be resource impacts on industry testing of new plumbing materials for silicon leaching • it is unclear what the resource impacts on the implementation of a new guideline value on AZ/NZS 4020 would be, including the impacts on the WaterMark certification process for plumbing products. • there may be implications for the maximum impurity level of treatment chemicals.
Decision	• In December 2023, Members agreed that no health-based guideline value should be set for silicon or silicon copper alloys, as health effects are expected to occur at levels much higher than concentrations expected in Australian drinking water supplies. Members agreed that the derivation of the levels at which health effects are expected to occur for silicon (rounded to 100 mg/L) should be provided in the fact sheet. Members also agreed that the health-based guideline value should be reported to one significant figure for consistency with rounding conventions outlined in the Guidelines.	

- In March 2024, Members agreed to establish a health-based guideline value for silicon of 100 mg/L based on health considerations. This change to the guideline recommendation for silicon was made to address feedback from members of the enHealth Water Quality Expert Reference Panel who raised concerns about potential confusion from end users.

References

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Takizawa Y, Hirasawa F, Noritomi E, Aida M, Tsunoda H, Uesugi S (1988). Oral ingestion of syloid to mice and rats and its chronic toxicity and carcinogenicity.

DRAFT Evidence to decision table – Selenium (CAS 7782-49-2)

The Evidence to Decision (EtD) table below is intended to capture key factors considered by NHMRC and the Water Quality Advisory Committee when comparing and deciding on potential guideline options. This is in alignment with NHMRC Standards for Guidelines. This table has been updated or amended to capture additional information provided through stakeholder feedback from targeted/public consultation and any changes to advice made as a result by NHMRC and the Water Quality Advisory Committee.

Criteria	OPTION 1: - Maintain the current health-based guideline value for selenium of 0.01 mg/L	OPTION 2: - Lower health-based guideline value for selenium in drinking water to 0.004 mg/L
Example recommendation	*Current wording: Based on health considerations, the concentration of selenium in drinking water should not exceed 0.01 mg/L.*	*Based on health considerations, the concentration of selenium in drinking water should not exceed 0.004 mg/L.*
Health evidence profile and supporting information	The current health-based guideline value of 0.01 mg/L for selenium in drinking water was derived using an acceptable daily intake of 0.24 mg/day. The underpinning study by Longnecker *et al*. 1991 was a 2-year study on 140 people where no health effects were reported with the level of selenium intake. The current fact sheet for selenium was last endorsed in 1996. It was prioritised for review by NHMRC with advice from the jurisdictions and the Water Quality Advisory Committee as there were concerns that it may no longer be considered protective of public health.	An initial screening review of existing health-based guidance/guidelines for selenium identified a number of potential guideline values that were found suitable to adopt/adapt for the Australian context. However, an evidence scan of the published literature identified a number of primary studies that required review. A follow-up review of the primary literature published since 2010 found one human study that could be considered for potential guideline derivation. There is high confidence in the evidence for selenium exposure and mild effects of selenosis (i.e. alopecia). A lowest observed adverse effect level (LOAEL) of 255 µg Se/day (as diet and supplemental selenium) was determined from a human controlled trial by Lippman *et al*. 2009. These findings are supported by a separate review recently published in 2023 by the European Food Safety Authority (EFSA). EFSA

		determined an upper daily limit for selenium of 255 µg Se/day based on selenosis, finding a high level of certainty in the Lippman *et al*. 2009 cohort study. The review also found that while there was evidence of potential other health effects (such as risk of Type 2 diabetes), there was insufficient dose-response information to determine a suitable NOAEL or LOAEL for other potential health effects of selenium exposure.
Exposure profile	Many Australian distributed drinking water supplies contain relatively low selenium levels (i.e. typically <2 µg/L), which are lower than both guideline options. It is noted, however, there are some locations around Australia where communities rely on source waters that due to their geological origin may contain selenium concentrations higher than the current guideline value (e.g. up to 12 µg/L observed in NT and QLD). It is also noted that lowering the guideline value will increase the number of exceedances observed around the country. It is noted that exposure to selenium may also theoretically occur from leaching of selenium from low-lead plumbing materials. Insufficient leaching data regarding selenium in plumbing materials were identified in the review.	
Health benefits vs harms	As this guideline value is based on an older review and does not consider more recent studies that have resulted in changes in advice by international organisations, it is uncertain whether this guideline option would be considered protective of public health. Given the lack of leaching data for selenium copper alloys used in plumbing products, it is also unclear if this guideline value would be protective of public health in this exposure scenario. Publication of a fact sheet including uncertainties around actual risks from leaching from plumbing may help build awareness and drive research in this area.	This guideline option is the most conservative option and will be protective of public health. Given the lack of leaching data for selenium copper alloys used in plumbing products, it is also unclear if this guideline value would be protective of public health in this exposure scenario. However, in the absence of leaching data, a lower health-based guideline value will ensure testing of products to ensure they do not exceed this level before they enter the market. It may also allow generation of datasets to help clarify the level of risk to consumers from in-premises leaching. Publication of a fact sheet including uncertainties around actual risks from leaching from plumbing may help build awareness and drive research in this area.

Values and preferences (consumers, communities)	The values and preferences of consumers regarding selenium in drinking water, or selenium leaching from 'lead-free' plumbing materials on the market is unknown. However, it is reasonable to assume that consumers and communities would expect that: • supplied drinking water is safe to drink at the tap, regardless of whether leaching of chemicals from plumbing occurs beyond the point of supply or not • that new/emerging risks to public health from drinking water are considered by NHMRC and appropriate action is taken depending on the risks to public health and that all guideline options under consideration will be protective of public health • plumbing materials available for sale in Australia (particularly 'lead-free' WaterMark products) will have been tested rigorously and found to be compliant with Australian standards, and will be safe to install and use under typical conditions • that the materials used to replace lead in plumbing will not leach chemicals into drinking water that might cause harm to public health.	
Acceptability (other key stakeholders)	This guideline option will be less acceptable to many stakeholders who are responsible for regulating public health and/or drinking water. Selenium was flagged as a priority chemical for review in 2016 by most jurisdictional health authorities on the enHealth Water Quality Expert Reference Panel as the underpinning health advice was considered out of date.	This guideline option will provide the most certainty in the safest level of selenium in drinking water for: • health regulators and/or drinking water authorities • water and construction/plumbing and manufacturing industries • consumers. Potential impacts of this guideline option on stakeholders that might influence acceptability include: • increased water treatment requirements to meet the guideline value • increased reporting of exceedances, as there could potentially be more drinking water supplies that will now exceed the guideline value • changed product testing requirements for industry; however, this might be balanced by greater confidence in product safety

		• health-based guideline values for selenium set by similar international agencies. Further information on selenium leaching data will provide greater certainty that the proposed guideline value will be protective of health from this exposure scenario.
Feasibility	This guideline option is feasible as no changes to current practice are required.	This guideline option is technically feasible. The concentration of the candidate health-based guideline value of 0.004 mg/L would be achievable with existing treatment technologies and readily measurable with current commercial analytical techniques. If industry implement a product testing limit for selenium of 0.004 mg/L, this would be achievable with existing treatment technologies and readily measurable with current commercial analytical techniques.
Health equity impacts	Unclear.	Unclear. This option will be most conservative and protective of public health for the general population but depending on geographical and geological location the impacts of implementing this guideline option might be felt more in communities that have limited resources.
Resource impacts	No changes to current practice are required.	Additional resources might be required to meet the lowered health-based guideline value for selenium if it is introduced in the Guidelines, such as: • increased costs of treatment to remove excess selenium by water providers in areas where there are exceedances of selenium in source waters, noting that it is unlikely that additional water treatment will be required in most Australian supplies

		• additional costs to water providers and manufacturers might flow on to consumers • it is unclear what the resource impacts on the implementation of a lowered guideline value for selenium on AZ/NZS 4020 would be, including the impacts on the WaterMark certification process for plumbing products • there will be a flow on effect on the maximum impurity levels of selenium in water treatment chemicals – this might have additional resource impacts to achieve these purity standards.
Decision	• In December 2023, Members agreed that the health-based guideline value for selenium should be lowered from 0.01 mg/L to 0.004 mg/L based on health considerations. Members also agreed that the health-based guideline value should be reported to one significant figure for consistency with rounding conventions outlined in the Guidelines.	

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DRAFT Evidence to decision table – Lead (CAS 7439-92-1)

The Evidence to Decision (EtD) table below is intended to capture key factors considered by NHMRC and the Water Quality Advisory Committee when comparing and deciding on potential guideline options. This is in alignment with NHMRC Standards for Guidelines. This table has been updated or amended to capture additional information provided through stakeholder feedback from targeted/public consultation and any changes to advice made as a result by NHMRC and the Water Quality Advisory Committee.

Criteria	OPTION 1: - Maintain the current health-based guideline value for lead of 0.01 mg/L - Update supporting information in current fact sheet	OPTION 2: - Lower health-based guideline value for lead in drinking water to 0.005 mg/L - Update supporting information in current fact sheet
Draft recommendation	Current wording: *Based on health considerations, the concentration of lead in drinking water should not exceed 0.01 mg/L.*	New wording: *Based on health considerations, the concentration of lead in drinking water should not exceed 0.005 mg/L.*
Health evidence profile	The current health-based guideline value of 0.01 mg/L was endorsed in 1996. It is based on metabolic studies in infants that established a lead intake of 0.0035 mg Pb/kg body weight per day that does not result in an increase in lead retention (Ziegler *et al*. 1978, Ryu *et al*. 1983). The World Health Organization (WHO) guideline value for lead in drinking water has been 0.01 mg/L since 1993. This was originally based on the same metabolic studies as the NHMRC advice, but is no longer considered a health-based guideline value as it has been established that there is no longer a safe level of lead due to neurodevelopmental effects in infants (JECFA 2011a,b). WHO continues to recommend a provisional guideline value of 0.01 mg/L that is based on treatment performance and analytical	An initial screening review of existing health-based guidance/guidelines for lead identified a number of potential guideline values that were found suitable to adopt/adapt for the Australian context, including the 2015 NHMRC advice on blood lead levels. However, as the potential guideline candidates were either not informed by recent reviews or not considered health-based, it was determined that an additional review of the recent literature was warranted. A follow-up review of the primary literature published since 2013 found that there is highest confidence in the body of evidence for an association between exposure to lead and neurobehavioural effects (including reductions in intelligence quotient). However, the results of these studies do not appear to alter the dose response

	achievability, while encouraging lead levels to be minimised as much as practically possible. It is noted that the current NHMRC fact sheet for lead acknowledges the development of blood lead level advice by NHMRC and states that the current guideline value of 0.01 mg/L should be regarded as an interim value pending the findings of a review. NHMRC reviewed the health effects of lead in 2015 and recommended that investigation of potential sources of lead exposure should be investigated if blood lead levels exceed 5 mg/dL. This 2015 advice is considered as part of the review in Option 2 and forms the basis of the proposed health-based guideline value. As the level of lead intake used in the current guideline derivation is no longer considered safe based on neurodevelopmental effects observed in infants exposed to low levels of lead, it is uncertain whether the current NHMRC health-based guideline value for lead of 0.01 mg/L is still protective of health.	relationship and conclusions already established by NHMRC in 2015 for blood lead levels. Deriving a candidate drinking water guideline for lead with the general aim of reduction / minimisation of lead exposures to a target of <5 µg/dL results in a health-based guideline value of 0.005 mg/L. This approach would be consistent with current Australian science policy to minimise exposure to lead in the most sensitive population groups (infants, children and pregnant women). It is noted that a 2021 European Union directive published since the initial screening of existing guidance/guidelines has lowered the level of lead in drinking water to 0.005 mg/L, to be implemented by 2036. It is also consistent with health advice and approach for lead in drinking water published by Health Canada in 2019.
Exposure profile	Leaching data from plumbing systems indicates that lead leaching is site specific and occurs in-premises. It is also dependent on water quality characteristics and the type of plumbing materials used.	
Health benefits vs harms	There have been concerns that the current guideline value does not provide adequate protection against potential lead leaching in-premises.	This guideline option is the most conservative option and will be protective of public health at the tap.
Values and preferences	Human exposure to lead is an ongoing concern to consumers and communities, particularly to those who live in communities where drinking water supplies (including rainwater tanks) can be exposed to lead dust or where plumbing infrastructure may include historic	

(consumers, communities)	lead pipes. It is noted that the introduction of new 'lead-free' plumbing materials on the market may alleviate some concerns and could reduce overall exposure to lead. It is reasonable to assume that consumers and communities would expect that: • supplied drinking water is safe to drink at the tap, regardless of whether leaching of chemicals from plumbing occurs beyond the point of supply or not • that new/emerging risks to public health from drinking water are considered by NHMRC and appropriate action is taken depending on the risks to public health and that all guideline options under consideration will be protective of public health • plumbing materials available for sale in Australia (particularly 'lead-free' WaterMark products) will have been tested rigorously and found to be compliant with Australian standards, and will be safe to install and use under typical conditions • that the materials used to replace lead in plumbing will not leach chemicals into drinking water that might cause harm to public health.	
Acceptability (other key stakeholders)	Given that the health evidence will have been reviewed and a justification for not setting a guideline value published in a fact sheet, this guideline option will provide some certainty that low lead plumbing materials are safe for use for: • health regulators and/or drinking water authorities • water and construction/plumbing and manufacturing industries • consumers. However, given as there is uncertainty about exposure as there is insufficient leaching data available, it might be unacceptable to some stakeholders to not set a guideline value that might protect health in the absence of exposure data. As a lower health-based drinking water guideline value for lead has been established by similar international agencies, consumer acceptability for this option is likely to be lower.	This guideline option will provide the greatest confidence in plumbing materials that contain lead for: • health regulators and/or drinking water authorities • water and construction/plumbing and manufacturing industries • consumers. Factors that might impact acceptability of this guideline option for stakeholders: • increased regulatory burden for health regulators and/or drinking water authorities as more exceedances might be detected as a result of lowering the guideline value; however, this option will be most protective of public health so might be more acceptable from the health protection perspective. • testing requirements for industry will increase as a new health-based guideline value will be embedded in the

		testing requirements for AS/NZS 4020; however, this might be balanced by greater confidence in product safety. • a similar health-based guideline value has been established by other international agencies.
Feasibility	This guideline option is feasible as no changes to current practice are required.	This guideline option is technically feasible. The concentration of the candidate DWG of 0.005 mg/L would be achievable with existing treatment technologies and readily measurable with current commercial analytical techniques. The implementation of low-lead replacement plumbing products will also support feasibility of achieving the candidate DWG of 0.005 mg/L across the general population.
Health equity impacts	Lead leaching has been an issue in communities with ageing infrastructure and plumbing in houses. Replacement of ageing/lead plumbing with 'lead-free' options will be required in all new builds from May 2026 and is intended to improve health outcomes for the Australian population by minimising exposure to lead. Current guideline value may not be protective of most sensitive populations.	Lead leaching has been an issue in communities with ageing infrastructure and plumbing in existing houses and it may also be an issue in the early years of occupancy of new houses that have used currently available fittings. Replacement of ageing/lead plumbing with 'lead-free' options will be required in all new builds from May 2026 and is intended to improve health outcomes for the Australian population by minimising exposure to lead. This option will be most conservative and protective of public health for the general population, including groups that may be most sensitive (e.g. infants, children and pregnant women) or more exposed to lead leaching due to socioeconomic factors.
Resource impacts	None.	It is unclear what the resource impacts on the implementation of a new guideline value on AZ/NZS 4020 would be, including the

		impacts on the WaterMark certification process for plumbing products. There may be a flow on impact on the maximum impurity levels of lead in water treatment chemicals, which may have additional resource impacts to achieve these purity standards.
Decision	• In December 2023, Members agreed the health-based guideline value for lead should be lowered from 0.01 mg/L to 0.005 mg/L based on health considerations.	

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Evidence to decision table – Manganese (CAS 7439-96-5)

The Evidence to Decision (EtD) table below is intended to capture key factors considered by NHMRC and the Water Quality Advisory Committee when comparing and deciding on potential guideline options. This is in alignment with NHMRC Standards for Guidelines. This table has been updated or amended to capture additional information provided through stakeholder feedback from targeted/public consultation and any changes to advice made as a result by NHMRC and the Water Quality Advisory Committee.

Health-based guideline value

Criteria	OPTION 1: Maintain status quo – Current health-based guideline value of 0.5 mg/L (NHMRC 2011)	OPTION 2: Establish new health-based guideline value for manganese in drinking water of 0.1 mg/L (note – aesthetic guideline value discussed separately)
Example recommendation	*Manganese would not be a health consideration unless the concentration exceeded 0.5 mg/L.*	*Based on health considerations, the concentration of manganese in drinking water should not exceed 0.1 mg/L.*
Health evidence profile	The current health-based guideline value of 0.5 mg/L was last endorsed by NHMRC Council in 2011. It is based on a total dietary intake of manganese of 10 mg/day as recommended by WHO in 1973. WHO reviewed their drinking water guideline value in 2021 based on emerging evidence that oral intake was potentially important for manganese toxicity. This reassessment considered more recent epidemiological data that indicated the potential for adverse effects in populations exposed to manganese concentrations lower than the previously established WHO health-based value for	A targeted review of recent guidance/guidelines published by WHO (2021, 2022), Health Canada (2019) and EFSA (2023) identified neurotoxicity as an endpoint of concern following oral exposure to manganese (NHMRC 2024). Some of these studies assessed neurodevelopmental endpoints in early life that were supported by corresponding neurochemical findings. Both WHO and Health Canada agreed that results from the most robust animal dose–response studies identified a neurodevelopmental lowest observable adverse effect level for manganese of 25 mg/kg bw/day in rats following oral exposure in early life. These studies characterised parameters of executive function that reflect effects reported in human epidemiological studies, such as behavioural hyperactivity and learning deficits following early-life exposures.

	drinking water. The WHO guideline value was amended in 2022 to a provisional guideline value of 0.08 mg/L based on neurological effects in neonatal rats. This updated guideline value was designated as provisional due to the high level of uncertainty in the database, as reflected in the composite uncertainty factor of 1,000. As the level of manganese intake used in the current guideline derivation is much higher than the recently derived safe levels of manganese intake for different age cohorts of 2–8 mg/day by EFSA (2023) it is uncertain whether the current NHMRC health-based guideline value for manganese of 0.5 mg/L is protective of children's health. In particular, EFSA recommend only 2 mg/day for infants aged ≥4 months to <1 year as they absorb more and excrete less manganese. The current factsheet states that "Owing to the low solubility of manganese in gastric juices, only 3–8% of ingested manganese is absorbed by the gastrointestinal tract." However, in a nutrient balance study in infants, Dörner et al. (1989) reported apparent relative retention of manganese from breast milk of 37% and 16%–31% from infant formula. EFSA note the scarcity of data regarding the maturation processes of manganese homeostatic mechanisms in human infants, and that the available	The quality of the human epidemiological studies is variable, particularly with respect to the reliability of exposure estimates. No single study shows a clear causal relationship between manganese dose and neurotoxicity. However collectively human epidemiological studies provide qualitative support that neurotoxicity is also relevant in humans. Evidence also suggests that the cognitive and neurobehavioural effects in children following exposure to manganese may be related to effects on the dopaminergic system during development. Infants, and especially neonates, have greater manganese absorption and a reduced capacity for biliary excretion compared to adults. As a result, neonates and young children will acquire a higher body burden of manganese from a given exposure than will adults; this, along with the important neurodevelopmental processes occurring in neonates, renders them particularly susceptible to manganese-induced toxicity.

	data are inadequate to determine whether infants have a similar capacity as older age groups to regulate manganese body burden. Neurotoxicity is a well-established adverse effect of excess manganese exposure. However, data to identify critical dietary intakes associated with increased risks of neurotoxicity are lacking in both animals and humans.	
Exposure profile	Manganese is present in air, food, consumer products, soil and drinking water; however, the main source of exposure is through diet, the main contributors being grain-based products and teas. The current NHMRC factsheet estimates that the average dietary intake of manganese is 2–4 mg per day (NHMRC 2011). The current manganese fact sheet reports that in major Australian reticulated supplies, manganese concentrations can range up to 1.41 mg/L, with typical concentrations less than 0.01 mg/L. For regional NSW, a median value of 0.005 mg/L was found over a nine-year period (NHMRC 2011). A summary of recent distributed drinking water supply monitoring data for manganese: • Mean concentration **<0.002 – 0.026 mg/L** and maximum concentration of **0.055 mg/L** was recorded across urban and regional Western Australia during 2022–2023 (Water Corporation 2023). • Average manganese concentrations of **<0.005–0.03 mg/L** in town centres and **<0.005–0.3 mg/L** in 72 regional First Nations communities of the Northern Territory during 2021–2022. Exceedances were noted in Pine Creek urban centre (**0.7 mg/L),** and regional towns Nauiyu (**0.8 mg/L**) and Nganmarriyanga (**0.3 mg/L**) that rely on bore water (Power & Water Corporation 2023). • Average concentrations of **<0.001–0.006 mg/L** were measured in the bulk water supplied to councils and water retail distributors in South-East Queensland by Seqwater from February 2023–January 2024 (Seqwater 2024). • Mean concentration in Adelaide's metropolitan distribution system (customer tap water quality) measured **0.0015 mg/L** and a maximum of **0.0075 mg/L** during 2022–2023. All regional drinking water distributions systems including those supplying First Nations communities (regional customer tap water quality) recorded mean concentrations in the range **<0.0001–0.0208 mg/L** during 2022–2023 (South Australian Water Corporation 2023). • Manganese concentrations measured in drinking water derived from the six major Melbourne storage reservoirs following primary treatment processes were in the range **0.0001–0.0138 mg/L** during 2022 (Melbourne Water 2023).	

	• Average concentration measured at participating customers' taps was **0.004 mg/L** (range **<0.001–0.183 mg/L**) in Canberra during 2022–2023 (Icon Water 2023). Other factors that might influence the extent of manganese toxicity specific to drinking water exposure, include the bioavailability of differing chemical forms and valence states present in drinking water. For example, when reducing conditions are present in groundwater, higher concentrations of dissolved manganese (II) are favoured; up to 1300 µg/L in neutral groundwater and 9600 µg/L in acidic groundwater have been reported (ATSDR, 2012). Surface water supplies such as lakes and reservoirs can become seasonally stratified, limit mixing can cause the lower sections of the water body to become anoxic. This allows release of dissolved Mn(II) into the water column from manganese oxides present in sediments at the bottom of the water body. In addition, low levels of manganese in source or treated water can accumulate in the distribution system and periodically release manganese to result in high levels at the tap. Releases of manganese can also occur periodically due to physical or hydraulic disturbances to the system (e.g. mains breaks or hydrant flushing) or changes in water chemistry (e.g. changes in pH, temperature, chlorine residual, and source water type/blending).	
Health benefits vs harms	The current guideline value may not provide adequate protection against possible neurotoxic effects in developing infants and children, or adults.	While there is some uncertainty in the studies used to inform this guideline option, this guideline option is conservative and precautionary with uncertainty factors incorporated to account for study deficiencies. It is considered to be protective of health for the general population, including infants and children who are most sensitive.
Values and preferences (consumers, communities)	It is reasonable to assume that all consumers and communities would expect that: • supplied drinking water is safe and aesthetically pleasing to drink, • that new/emerging risks to public health from drinking water are considered by NHMRC and appropriate action is taken depending on the risks to public health and that all guideline options under consideration will be protective of public health. Communities and consumers might perceive the aesthetic qualities of manganese in drinking water supplies more than the health effects. At levels as low as 0.02 mg/L, manganese as insoluble manganese oxides in water supplies may cause discoloured water, staining of laundry and plumbing fixtures and accumulate as oxide deposits in the distribution system, which may slough off as a black precipitate. In contrast, soluble manganese (II) is colourless and visually undetectable at concentrations as high as 506 mg/L (WHO	

	2021). The US EPA (2024a) note that manganese may introduce a black to brown colour, black staining and a bitter metallic taste that affects the aesthetic qualities of drinking water. Removal of manganese from drinking water will support greater consumption of drinking water and remove the need to purchase bottled drinking water for cooking and drinking thus removing an unnecessary economic burden for communities that do not receive aesthetically acceptable drinking water.	
Acceptability (other key stakeholders)	There might be some concerns that NHMRC is not aligning with international advice on manganese from agencies such as WHO and Health Canada if the current guideline value is retained. Water providers responsible for implementing the Guidelines in regions where the manganese concentration in source or drinking water is high may be less willing to commit resources to implement and monitor lower guideline values if there is uncertainty in the evidence base for any proposed changes.	The proposed lower guideline option for manganese will be the more conservative option and may be more acceptable to stakeholders such as health regulators from a health protection perspective. However, the acceptability of this guideline option to stakeholders who implement the Guidelines may be affected by the certainty of the underpinning evidence. Stakeholders who may have higher resource impacts if this guideline option is implemented may find it less acceptable if the justification for a change in practice is based on low quality evidence. It is noted that many water providers currently monitor and report on whether drinking water meets the aesthetic guideline value of 0.1 mg/L for manganese. The lower guideline option, while inherently more conservative and health protective, was found to be underpinned by key studies that were assessed by EFSA (2023) as having a higher level of uncertainty in their study quality, such as risk of bias in terms of blinding, randomization and allocation concealment that may have impacted the study outcomes. However, there may be increased confidence in the lower guideline value due to the high composite uncertainty factor (1,000) applied in the guideline derivation to account for deficiencies in study design and extrapolation to humans. The WHO and Health Canada applied that same uncertainty factor (1000) to the data to derive a health-based guideline value for manganese. Other factors that might affect acceptability of a lower guideline value for stakeholders include:

		• increased regulatory burden for health regulators and/or drinking water authorities as more exceedances in drinking water supplies might be detected as a result of lowering the guideline value. • monitoring requirements for water providers may increase, especially in areas with higher levels of manganese in source waters. • lower health-based guideline values have been established by other international agencies.
Feasibility	This guideline option is feasible as no changes to current practice are required.	This guideline option is technically feasible using current commercial and analytical techniques. Manganese concentrations in drinking water are easily lowered to less than 0.05 mg/L using common water treatment methods, including oxidation/filtration, adsorption/oxidation, softening/ion exchange and biological filtration methods. In well-operated and optimised systems, manganese concentrations can be reduced to less than 0.02 mg/L (Health Canada 2019, WHO 2022). Table A5.1 in the WHO guidelines (2022) includes the following water treatment methods for the removal of naturally occurring manganese from source waters and the manganese concentrations that can be achieved: • Dissolved manganese (II) can be removed through cation exchange in zeolite softening processes to <0.05 mg/L. • Precipitation and softening to <0.02 mg/L. • Oxidation of manganese using ozone followed by filtration to <0.05 mg/L. • Adsorption/oxidation including manganese greensand and other filter media coated with manganese oxides to <0.02 mg/L. • Oxidation using potassium permanganate followed by low pressure membrane filtration to <0.01 mg/L.

		Selection of the appropriate treatment system for manganese removal depends on the form of manganese (dissolved or particulate) present in the source water (Health Canada 2019, WHO 2022).
Health equity impacts	There is uncertainty if this guideline option is protective of health for more sensitive populations (e.g. bottle-fed infants), particularly those who may be more exposed to manganese based on their geographic location and local water sources and treatment options. Currently, some rural and remote communities in Australia may only have access to water containing unsafe levels of manganese that may affect the long-term health of children and other sensitive populations.	This guideline option is more conservative than the current NHMRC advice and is considered protective of public health for the general population. This includes groups that may be more sensitive (e.g. bottle-fed infants) and populations who may be more exposed to manganese from their local water sources.
Resource impacts	None. There would be no change in practice if the current guideline value is retained.	The proposed guideline option may have resource impacts for the water sector where utilities are not currently meeting (or aiming for targets lower than) the current aesthetic guideline value of 0.1 mg/L to limit consumer complaints related to discoloured water and visible particulates in their drinking water. Additional monitoring and treatment programs (including infrastructure) may be required to treat drinking water supplies to meet lowered guideline values, particularly in areas where lowering the guideline value may result in increased exceedances detected in communities. The cost of water treatment to remove manganese from drinking water may be challenging for water providers or communities relying on local bore water or water sources affected by seasonality and other weather events. For instance, Power and Water Corporation (2020, 2023) report:

		• A peak in water quality complaints during May, may be due to the change in weather and subsequent stratification during the dry season. These layers in the Darwin River Reservoir mix once the surface temperature cools during a monsoonal event or when the dry season trade winds and cool nights arrive producing discoloured water throughout the reservoir and allowing low quality anoxic water from the depths of the reservoir to mix with surface waters and to be drawn into the supply. • After heavy rainfall, the Katherine River experiences sudden inflows of runoff water that impact its quality and the ability for it to be adequately treated to the required drinking water standards. • Most regional towns in the Northern Territory rely on groundwater that is only treated with chlorine or UV radiation to remove microorganisms. Water providers may be unwilling to cover increased operational costs if there is lower certainty in the evidence for a lower guideline value. Resulting costs for additional treatment of drinking water supplies or investment in appropriate treatment technologies may be borne by local water providers or communities. This may have flow on costs to consumers.
Decision	• In March 2024, Members agreed that the health-based guideline value for manganese should be lowered from 0.5 mg/L to 0.1 mg/L based on health considerations. Members also agreed that the health-based guideline value should be reported to one significant figure for consistency with rounding conventions outlined in the Guidelines.	

Aesthetic guideline value – manganese

Criteria	OPTION 1: Maintain status quo – aesthetic guideline value of 0.1 mg/L (NHMRC 2011).	OPTION 2: Establish new aesthetic guideline value for manganese in drinking water within the range 0.01–0.1 mg/L
Example recommendation	*Based on aesthetic considerations, the concentration of manganese in drinking water should not exceed 0.1 mg/L, measured at the customer's tap.*	*Based on aesthetic considerations, the concentration of manganese in drinking water should not exceed [selected concentration] measured at the customer's tap.*
Evidence profile	The current aesthetic guideline value of 0.1 mg/L is based on practical experience and has been reported by utilities to be acceptable to customers. The discretionary target of 0.01 mg/L at the treatment plant is also based on experience; that although manganese accumulates in distribution systems, a plant producing 0.01 mg/L generally does not generate customer complaints, while a concentration of 0.02 mg/L or more tends to lead to various problems (NHMRC 2011).	The aesthetic guideline value for the manganese concentration in drinking water is 0.02 mg/L in Canada and 0.05 mg/L in the USA and European Union (US EPA 2024, EU 2024, Health Canada 2019). These values are based on the level at which manganese precipitates can discolour water, stain laundry, form deposits in plumbing, and alter palatability and consumer acceptability. WHO states that insoluble manganese can cause aesthetic effects at 0.02 mg/L (WHO 2022). The US EPA notes the following aesthetic effects above 0.05 mg/L – black to brown colour; black staining; bitter metallic taste (US EPA 2024). The current Australian fact sheet suggests a discretionary target of 0.01 mg/L at the water treatment plant (NHMRC 2011).
Exposure profile	See Exposure Profile for health-based guideline value for some information on levels of manganese in Australia. In addition: • The regional NT communities of Nauiyu and Nganmarriyanga recorded an average manganese concentration of **0.3 mg/L** during 2021–2022 which exceeded the aesthetic guideline value. Maximum concentrations of **0.8 mg/L** and **0.3 mg/L** were recorded in Nauiyu and Nganmarriyanga respectively which rely on bore water, and **0.7 mg/L** in the Pine Creek urban centre. Average manganese concentrations of **<0.005–0.03 mg/L** in town centres and **<0.005–0.3 mg/L** in 72 regional First Nations communities of the Northern Territory were reported during 2021–2022 (Power & Water Corporation 2023). • No exceedances of the manganese aesthetic guideline value (0.1 mg/L) were detected in the six regions tested by Water Corporation over the 2022-2023 report period. Mean concentrations ranging between **<0.002 – 0.026 mg/L** and a maximum	

	concentration of **0.055 mg/L** were recorded across urban and regional Western Australia during 2022–2023 (Water Corporation 2023). Consumer complaints regarding colour and taste of drinking water may provide an indication of exposure to manganese if the chemical is at least partly responsible for changes in aesthetic water quality, however soluble manganese(II) will not be visible to consumers.	
Values and preferences (consumers, communities)	Aesthetic issues with manganese in drinking water can be a problem in some regional areas of Australia and can be the cause of some consumer complaints about discoloured drinking water. Lowering the aesthetic guideline value will likely be supported by consumers (noting that this might depend on a willingness to pay), particularly those communities that experience regular issues with aesthetic water quality caused by manganese. It is likely that removal of soluble and insoluble manganese from drinking water will make the water more appealing to consumers as manganese salts will not discolour the water or laundered clothing and the water will not have an unusual taste. An EU technical report (WHO 2017) notes that at levels exceeding 0.1 mg/L (100 µg/L), manganese in water supplies causes an undesirable taste in beverages and the US EPA notes that concentrations above 0.05 mg/L will have a noticeable bitter metallic taste (US EPA 2024a).	
Acceptability (other key stakeholders)	This option will be more acceptable to some water providers who already have challenges meeting the current aesthetic guideline value.	Lowering the aesthetic guideline value will have varying levels of acceptability for different stakeholders depending on the resulting impacts, including: • increased regulatory burden for health regulators and/or drinking water authorities as more exceedances in drinking water supplies might be detected as a result of lowering the guideline value. • monitoring and water treatment requirements for water providers may increase, especially in areas with higher levels of manganese in source waters.
Feasibility	Some water providers already have challenges meeting the current aesthetic guideline value of 0.01 mg/L.	This guideline option is technically feasible using current commercial and analytical techniques. Manganese concentrations in drinking water are easily lowered to less than 0.05 mg/L using common water treatment methods, including oxidation/filtration, adsorption/oxidation, softening/ion exchange and

		biological filtration. In well-operated and optimised systems, manganese concentrations can be reduced to less than 0.02 mg/L (Health Canada 2019, WHO 2022). Table A5.1 in the WHO guidelines (2022) includes the following water treatment methods for the removal of naturally occurring manganese from source waters and the manganese concentrations that can be achieved: • Dissolved manganese(II) can be removed through cation exchange in zeolite softening processes to <0.05 mg/L. • Precipitation and softening to <0.02 mg/L. • Oxidation of manganese using ozone followed by filtration to <0.05 mg/L. • Adsorption/oxidation including manganese greensand and other filter media coated with manganese oxides to <0.02 mg/L. • Oxidation using potassium permanganate followed by low pressure membrane filtration to <0.01 mg/L. Selection of the appropriate treatment system for manganese removal depends on the form of manganese (dissolved or particulate) present in the source water (Health Canada 2019, WHO 2022).
Equity impacts	Consumers and communities that regularly experience exceedances of the current aesthetic guideline value of 0.1 mg/L often do not have the required water treatment capabilities to remove manganese to an acceptable level. Further reduction of the aesthetic guideline value may exacerbate this inequity if there isn't a resulting improvement in treatment capabilities.	
Resource impacts	This aesthetic guideline option will have little impact on stakeholders who are currently meeting the current value of 0.1 mg/L. Water providers or communities who struggle to meet this value will have continued issues to maintain/meet this level.	Lowering the aesthetic guideline value may have resource impacts on the water sector, where utilities are not currently meeting (or aiming for targets lower than) the current aesthetic guideline value of 0.1 mg/L to limit consumer complaints related to discoloured water and visible particulates in their drinking water. Additional monitoring and treatment programs (including infrastructure) may be required to treat drinking water supplies to meet lowered guideline

		values, particularly in areas where lowering the guideline value may result in increased exceedances detected in communities. The cost of water treatment to remove manganese from drinking water may be challenging for water providers or communities relying on local bore water or other sources affected by seasonality and other weather events (see examples in the health-based guideline table above). Water providers may be unwilling to cover increased operational costs if there is lower certainty in the evidence for a lower guideline value. Resulting costs for additional treatment of drinking water supplies or investment in appropriate treatment technologies may be borne by local water providers or communities. This may have flow-on costs to consumers.
Decision	• In March 2024, Members agreed the aesthetic guideline value for manganese should be lowered from 0.1 mg/L to 0.05 mg/L based on providing safe clear, untainted water to consumers; managing the risks of manganese precipitates in the water distribution system and at the customer's tap; and readily achievable concentrations following water treatment. Members also agreed that the aesthetic guideline value should be reported to one significant figure for consistency with rounding conventions outlined in the Guidelines.	

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Appendix B – enHealth feedback on draft guidance

The enHealth Water Quality Expert Reference Panel was formally consulted on the draft public consultation guidance in April – May 2024, including:

- a new information sheet on lead replacements in plumbing products
- new fact sheets on bismuth and silicon
- updated fact sheets for lead, selenium and manganese
- a number of proposed consequential edits to the Guidelines.

NHMRC sought feedback on the following:

1. Is the draft guidance relevant, accurate and easy to understand?
2. Do you support the approaches taken to review the evidence and develop the guidance?
3. Do you have any other comments about implementation or feasibility of the proposed health-based guideline values?

Members also had the opportunity to provide specific comments and/or tracked changes in the documents provided.

Summary of feedback received

Feedback received on the draft guidance material was overall supportive of the material developed and the proposed revisions to current fact sheets. In some instances, specific edits were made to clarify or simplify language used. Some common areas of feedback included:

- clarifying the proposed guideline recommendation for bismuth and silicon, given that a level at which health effects may occur was provided but a health-based guidance value was not established, stating that this may be confusing for end users
- raising the likelihood of impacts to resourcing in order to manage expected increases in exceedances for chemicals where a lower guideline value has been proposed (particularly for lead and manganese)
- the need for consistency in terminology throughout the guidance material, particularly relating to alignment of descriptions used by the Australian Building Codes Board (ABCB)

- confirming, where appropriate, the detection/reporting limits for the measurement tests identified and typical levels found in Australian drinking water
- whether additional data specific to in-premise concentrations of lead replacements in plumbing products were available for inclusion in the fact sheets.

A summary of the feedback from the jurisdictions to the specific questions and responses are provided in **Table 3** (lead replacements in plumbing products) and **Table 4** (manganese) below.

Table 3. **2024 enHealth Water Quality Expert Reference Panel comments on the draft guidance (lead and lead replacements in plumbing products)**

#	Fact sheet	Relevant section	Feedback received	Action/Response
Question 1: Is the draft guidance relevant, accurate and easy to understand?				
1.	-	-	The Draft guidance (attachments A-F) are relevant, accurate and easy to understand – taking into account suggested changes in said documents.	Noted. Edits made where accepted.
2.	-	-	For the most part the guidance is relevant, accurate and comprehensible for non-technical readers.	Noted.
Question 2: Do you support the approaches taken to review the evidence and develop the guidance?				
3.	-	-	I support the approaches taken to review the evidence to develop the guidance.	Noted.
4.	-	-	The approaches to review the evidence and develop the guidance is consistent with NHMRC methods and is supported.	Noted.
Question 3: Do you have any other comments about implementation or feasibility of the proposed health-based guideline values?				

#	Fact sheet	Relevant section	Feedback received	Action/Response
5.	-	-	I have no specific comments about the implementation or feasibility of the proposed HBGV.	Noted.
6.	-	-	The main thing we wonder about is the impact of moving the lead HBGV from 0.01 to 0.005 mg/L. We are comfortable with the methodology for deriving the lower value, but note that compliance is likely to be a challenge in many parts of Australia, given the preponderance of legacy plumbing materials in everywhere but new builds.	Noted.
General comments:				
7.	General	-	The ABCB refers to the lead substitutes as Lead Free (with no hyphen, but capitals, and they don't appear to use the term low lead). The specific change made by the ABCB is for copper alloy plumbing products, and they do not seem to use the word brass at all. I have taken the approach that a specific mention of a replacement product should be to that metal/metalloid copper alloy plumbing product (e.g. selenium copper alloy), but a collective reference to all of these possible copper alloys can simply be as lead replacements in plumbing products. Suggested edits include: • Replace 'low lead' with 'Lead Free'. • Replace 'lead brass' to 'lead containing copper alloys'. • Replace '"Lead- Free" brasses' with 'Lead Free copper alloys'. • Replace 'lead brass' with 'copper alloys'. • Do not use the following terms – 'bismuth brass', 'selenium brass', 'silicon brass', 'graphite alloys', 'indium brass', 'gallium brass' and 'manganese/zinc alloys'.	Accepted. Updated text for consistency and as appropriate to balance with need for plain language. Some amendments made to align better with terminology used by ABCB (e.g. using Lead Free, copper alloy instead of brass).

#	Fact sheet	Relevant section	Feedback received	Action/Response
8.	General	-	Noting that the factsheets typically provide information on reticulated water values, given the focus on building guidance on internal plumbing is there scope (or ability) to provide typical in premises values like those added for lead?	Accepted. Limited to no data has been identified for lead replacements in premises as yet. If data becomes available during the consultation process it will be considered for inclusion in the fact sheet.
9.	General	-	Understanding that to characterise and confirm the assumptions made with any certainty, in house sampling will be required across an extended period. Furthermore, the novel lead replacement materials are relatively new and may not have degraded to a notable extent in the Australian context. For example, galvanised pipes which degrade over several years before causing discoloration of water is well understood, whereas the recent uptake of lead replacements means there is less information about performance under Australian conditions. There has been discussion that leaching of metals from plumbing fittings follows an inverted bell curve where the leaching pattern is greater at the start and end of the lifetime of the fitting.	Noted. Sampling is likely to be more consistent with the change to establishing health-based guideline values for bismuth and silicon.
10.	General	-	Is there opportunity for the WQAC or WQERP to work with water agencies, WSAA, WaterRA etc. to explore typical levels of metals and metalloids within household plumbing similar to what has been included in the lead fact sheet update?	Noted. Additional work with external agencies to generate in-premise water quality data is out of scope of this update; however, if relevant data is provided by stakeholders (such as during public consultation) it can be considered by NHMRC and the Committee when finalising the guidance.

#	Fact sheet	Relevant section	Feedback received	Action/Response
11.	General	-	In 2018, lead and other plumbing related metals were found in a number of drinking water fountains across Geelong at concentrations exceeding health-based guideline values. Interestingly, upon investigation, the drinking water fountains were found to have fittings with the WaterMark markings which should indicate that the products protect community health and safety. Following the numerous lead detections, the Australian Building Codes Board (ABCB) commissioned a research project into potential sources of lead in plumbing products and materials to better understand the nature and extent of the issue in Australia. This event shows that while the WaterMark Certification Scheme plays an important role in reducing lead and other metals in plumbing fittings it is no guarantee of final water consumed being lead free and/or protective of community health and safety. During the drinking water fountain issue, the robustness of the WaterMark certification process was raised. It is recommended that there is input to the guidance from the ABCB who manages and administers the scheme. The guidance should emphasise a whole of system approach to assessing potential risks of metal leaching and ensuring the appropriate selection of plumbing fixtures and follow up verification of in premises water quality.	Noted. Edits have been made in Section 9.6 to clarify the role of building and site owners and managers and plumbing oversight agencies. Input to guidance from the ABCB is out of scope of this particular update; however, the ABCB will be invited to comment on the draft guidance during public consultation and if required NHMRC will work to ensure that advice is consistent across agencies.
12.	Bismuth	TREATMENT OF DRINKING WATER "A single study investigated the use of absorption on the algae Spirogyra to remove various heavy metals (including 76% reduction of bismuth concentrations) from coal mine	Consider summarising the conclusions from Vetrivel 2017 or remove this sentence completely as it is not very relevant for drinking water.	Accepted. Text amended to remove reference.

#	Fact sheet	Relevant section	Feedback received	Action/Response
		wastewater (Vetrivel et al. 2017)."		
13.	Bismuth	HEALTH CONSIDERATIONS "For instance, one form of Pepto Bismol Ultra® (bismuth subsalicylate) contains approximately 303 mg of bismuth per tablet, with a maximum suggested dose of 8 tablets a day for adults. Similarly, bismuth subcitrate contains 108 mg of bismuth per tablet (Poddalgoda et al. 2020)."	Consider expressing the mass of bismuth in a daily defined dose (DDD) of a formulation, not mass of bismuth per tablet. DDDs are defined by the WHO and represent the average or typical dose prescribed for a pharmaceutical. Speaking in terms of number of tablets can be confusing as the number of tablets for a dose can change with time and between manufacturers.	Noted. Text updated to remove reference to proprietary information as conversion to therapeutic dosages is beyond the scope of this review.
14.	Bismuth	TYPICAL VALUES IN AUSTRALIAN DRINKING WATER "Concentrations of bismuth in drinking water in Western Australia (sample size >170) were found to be below the level of reporting (<0.005 µg/L) (Hinwood et al 2015)."	Is this an average figure or were all of the samples <0.005 ug/L? Might add value to put it in context?	Accepted. Text updated to reflect that bismuth was not detected in all samples tested.
15.	Bismuth	DERIVATION OF GUIDELINE "A health-based guideline value has not been established for bismuth at this time based on the low levels of bismuth found in Australian reticulated drinking water supplies."	Amend text to: 'A health-based guideline value has not been established for bismuth at this time as concentrations are likely to be considerably lower than the level that may cause health effects.' It's a subtle change, but an important one. Stating that it may be lower than levels we find in the retic, may influence risks assessment whereby it is not tested for.	Accepted in-principle. Section has been updated to reflect setting a health-based guideline value for bismuth in drinking water.

#	Fact sheet	Relevant section	Feedback received	Action/Response
16.	Bismuth	TYPICAL VALUES IN AUSTRALIAN DRINKING WATER	Is the data from WA the result of reticulation samples? Suggest the fact sheet acknowledges the limitation of applying WA information to other parts of Australia given the potential variation in local characteristics of groundwater and other sources such as desal water.	Noted. Text updated to reflect data from WA as an example only.
17.	Bismuth	"No health based guideline is considered necessary … as concentrations are likely to be considerably lower than the level that may cause health effect"	Yet there is a maximum recommended level set later in the text. This appears contradictory. The guideline also presumes that levels will never be found that exceed the maximum recommended level. Is this a safe presumption?	Text updated to reflect establishing health-based guideline values for bismuth and silicon in drinking water. A conservative and preventative approach has been taken to ensure consistency and avoid potential discrepancies across water suppliers.
18.	Bismuth Silicon		Could NHMRC explain its rationale for proposing a value 'at which health effects are expected to occur' but not making this value a health-based guideline value? I note the decision of WQAC members of December 2023 that '*no health-based guideline values should be set for bismuth and silicon or their brasses at this time, as health effects are expected to occur at levels much higher than concentrations expected in Australian drinking water.*' I understand there are many other characteristics that already have a health-based guideline value even though detections are very rare or very low concentrations	Text updated to reflect establishing health-based guideline values for bismuth and silicon in drinking water. A conservative and preventative approach has been taken to ensure consistency and avoid potential discrepancies across water suppliers.
19.	Bismuth Silicon	DERIVATION OF GUIDELINE "A health-based guideline value has not been established for bismuth/silicon at this time based on the low levels of	Amend text to: A health-based guideline value has not been established for bismuth/silicon at this time as concentrations are likely to be considerably lower than the level that may cause health effects.	Accepted in-principle. Text has been updated to reflect establishing health-based guideline values for bismuth and silicon in drinking water.

#	Fact sheet	Relevant section	Feedback received	Action/Response
		bismuth found in Australian reticulated drinking water supplies."	Note: Stating that it may be lower than levels we find in the reticulated system, may influence risks assessment whereby it is not tested for.	
20.	Silicon	GENERAL DESCRIPTION "Silicon is a ubiquitous element present in the environment and occurs naturally in foods as silicon dioxide (SiO_2, silica) and silicates."	Should this [silica] be silicon or silica?	No change made. SiO_2 is commonly known as silica.
21.	Silicon	TYPICAL VALUES IN AUSTRALIAN DRINKING WATER "However, concentrations of silicon can be calculated from the concentration of silica reported. For example, in 2019-2020, the Northern Territory reported average concentrations of silica of 11 to 104 mg silica/L (equating to 5.2 – 49 mg silicon/L). In Western Australia in 2019-2020, mean concentrations of silica ranged from 0.6 to 90 mg/L (equating to 0.28 – 42 mg silicon/L) (SLR 2023)."	I suggest including the calculation conversion factor here.	Accepted. Text updated to include conversion calculation.
22.	Silicon	TYPICAL VALUES IN AUSTRALIAN DRINKING WATER "However, concentrations of silicon can be calculated from the concentration of silica	Is the higher range in NT due to groundwater use?	No change. Reason for range not detailed in the Annual Report.

#	Fact sheet	Relevant section	Feedback received	Action/Response
		reported. For example, in 2019-2020, the Northern Territory reported average concentrations of silica of 11 to 104 mg silica/L (equating to 5.2 – 49 mg silicon/L). In Western Australia in 2019-2020, mean concentrations of silica ranged from 0.6 to 90 mg/L (equating to 0.28 – 42 mg silicon/L) (SLR 2023)."		
23.	Silicon	HEALTH CONSIDERATIONS "Limited epidemiological data suggests that silicon (as silica or metasilicate) in drinking water may have a protective effect on humans (Burton et al. 1980, Gillette-Guyonnet et al. 2007, Jacqmin-Gadda et al. 1996, Najda et al. 1991)."	In what way is silicon protective?	Text removed - the evidence evaluation report suggests that there may be a protective effect against aluminium and cognitive impairment, however there is limited information available in the review, given the focus was on establishing possible guideline values.
24.	Silicon	DERIVATION OF GUIDELINE "A level has been determined to provide advice on the concentration of silicon in drinking water at which negative health effects are expected to occur.	Is it appropriate to indicate the equivalent concentration for silica, or to spell out the silica - silicon conversion factor under "Typical Values in Australian Drinking Water"?	Accepted. Text amended to describe silica / silicon conversion factor.
25.	Selenium	GUIDELINE "Based on health considerations, the	The proposed guideline value is 10 times lower than current WHO provisional guideline of 0.04 mg/L, which is provisional because of uncertainties in the health database. I note	No changes made. Evidence review report considered a safety factor of 3

#	Fact sheet	Relevant section	Feedback received	Action/Response
		concentration of selenium in drinking water should not exceed 0.004 mg/L."	selenium is an essential trace element. Is a safety factor of 3 appropriate?	appropriate to balance the essentiality of selenium. Essentiality of selenium needs to be balanced with the potential for adverse effects. A safety factor of 3 is based on the findings of the evidence review report (i.e. the effect was a mild effect and the LOAEL is a minimal LOAEL. Additionally, an uncertainty factor for human variability was not included as the study was conducted in a large population of men and there is no indication that females or children are more susceptible).
26.	Selenium	MEASUREMENT	For selenium we are checking with our major lab if the limit of reporting would pose an issue for determining if results are below the proposed guideline value. This is just for noting and it may be possible to achieve a lower limit of reporting, but we would need to confirm.	Noted.
27.	Selenium	MEASUREMENT "Selenium can be measured in drinking water from 0.001 mg/L through inductively coupled plasma mass spectrometry (US EPA Method 200.8), inductively coupled plasma atomic emission spectroscopy (SLR 2022) or hydride generation	The LOR at the lab is 0.0001 mg/L for selenium in drinking water via ICPMS.	Noted. Text amended to include range.

#	Fact sheet	Relevant section	Feedback received	Action/Response
		followed by atomic absorption spectroscopy (APHA Method 3500-Se)."		
28.	Selenium	DERIVATION OF GUIDELINE	LOAEL quoted as mg/day. Comment: In the other Fact Sheets we give a NOAEL with the units of mg/kg body weight/day - which then forces one to incorporate the 70kg adult body weight into the equation. We don't do this for LOAEL?	Noted that it isn't consistent with other LOAEL/NOAEL used but daily intakes can be used to derive a guideline value in the absence of a bw dose. The primary study (Lippman et al 2009) does not provide mg/kg bw/day.
29.	Selenium	TYPICAL VALUES IN AUSTRALIAN DRINKING WATER	Note: In Victoria there is significant variation in water agencies reporting of selenium values in their drinking water quality annual reports available on their respective websites. The values reported indicate typical water levels at or below the limit of detection. However, a change in health-based guideline values will encourage water agencies to increase efforts to assess risk, monitor and report in their risk management plans. This may involve investigations into different contributing sources and typical levels in Victorian water sources.	Noted.
30.	Selenium		Support the use of updated information to inform the health-based guideline value.	Noted.
31.	Lead	Approximately 80% of the daily intake of lead is from the ingestion of food, dirt and dust. Food contains small but significant quantities of lead, which can increase when acidic food is stored in lead-glazed	It says 80% from food dirt and dust, but then food is small amount? Should the order be dirt, dust then food if they are more significant? Or is that only in contaminated areas?	No change made. Dust and dirt are only considered to be significant sources of lead if contaminated.

#	Fact sheet	Relevant section	Feedback received	Action/Response
		ceramic pottery or lead-soldered cans."		
32.	Lead	TREATMENT OF DRINKING WATER "For example, all repairs or installations of plumbing products in Australia should be undertaken by a licenced plumber having regard to materials in contact with drinking water being certified against relevant Australian standards, such as the WaterMark Certification Scheme, AS/NZS 4020 Testing of products for use in contact with drinking water."	Other references to the standard had the year referenced.	Noted. Text updated.
33.	Lead	MEASUREMENT "The limit of reporting ranges from 0.0002 to 0.05 mg/L depending on the laboratory test method."	The lab's LOR for lead in drinking water via ICPMS is 0.0001 mg/L.	Noted. Text amended to state 'typical' range.
34.	Lead	HEALTH CONSIDERATIONS "The International Agency for Research on Cancer has concluded that inorganic lead compounds are probably carcinogenic to humans (Group 2A - limited human data but sufficient evidence in animals) (IARC 2006). Organic lead compounds are not classifiable	Group 3 IARC reference required	Accepted. Text amended.

#	Fact sheet	Relevant section	Feedback received	Action/Response
		as to their carcinogenicity to humans (Group 3)"		
35.	Lead	GENERAL DESCRIPTION "Australian Building Codes Board as a plumbing product or material in contact with drinking water with a weighted average lead content of not more than 0.25%.	Add reference	Accepted. Reference added.
36.	Lead	GENERAL DESCRIPTION "Food contains small but significant quantities of lead, which can increase when acidic food is stored in lead-glazed ceramic pottery or lead-soldered cans."	Are lead-glazed ceramic pottery or lead-soldered cans still common?	Noted. Text updated with contemporary information.
37.	Lead	DERIVATION OF GUIDELINE As per current NHMRC advice on blood lead levels (NHMRC 2015b), and a relative source contribution that assumes that 20% of the total lead intake can be attributable to water consumption, this translates to a blood lead level attributable to exposure from lead in drinking water of 1 µg/dL (i.e. 5 µg/dL x 0.2 = 1 µg/dL).	Amend '...this translates to a blood lead level attributable to exposure from lead...' to '...this translates to a blood lead level assigned to exposure from lead...'. It may not be the correct term to use, but it is somewhat verbose to use attributable in two different contexts in the same sentence?	Accepted. Text amended.
38.	Lead	DERIVATION OF GUIDELINE	Reference required.	Accepted. Reference added.

#	Fact sheet	Relevant section	Feedback received	Action/Response
		"This approach is consistent with current Australian science policy to minimise exposure to lead in the most sensitive populations (infants, children, and pregnant women)."		
39.	Lead	"Lead can be present in drinking water, most commonly due to leaching from household plumbing systems containing lead."	The information provided should note that roof harvested water due to its typically acidic and soft nature can be contaminated lead from sources such as lead flashing and solder from solar panels etc. Information such as this will help to provide guidance on a wide range of water supply types where lead may not meet health-based guidance values.	No change made. Text mentions household plumbing systems which would include rainwater tanks and associated plumbing. Furthermore, guidance on the use of rainwater tanks (including lead flashing and solar panels) is available on the enHealth webpage.
40.	Lead	TYPICAL VALUES IN AUSTRALIAN DRINKING WATER "In major Australian reticulated drinking water supplies, total lead concentrations can range up to 0.01 mg/L, with typical concentrations less than 0.005 mg/L. A review found that mean levels in reticulated supplies in Australia appear to be lower than or similar to those in other developed countries (SLR 2023). The concentration of lead in water within premises may be	Note: 1. A limited review of reporting by Victorian water agencies indicates typical values equal to or less than 0.001 mg/L. However, some locations exceeded the proposed health-based guideline value. These can be found in water agencies drinking water quality annual reports available on their respective websites. 2. This is the only new or revised factsheet with information on typical water quality data for internal plumbing. Similar information for other plumbing associated metals and metalloids should be considered where available.	Noted. In-premises data for new lead replacement products is not currently publicly available. If data becomes available during the consultation process it will be considered for inclusion in the fact sheet.

#	Fact sheet	Relevant section	Feedback received	Action/Response
		higher, especially in older buildings, due to exposure of the water to lead-containing plumbing products. A review found several Australian and international studies that detected up to 0.162 mg/L of lead in drinking water due to leaching from lead-containing plumbing materials including taps and lead service lines, suggesting that leaching of lead from lead-containing plumbing materials can be substantial (SLR 2023)."		
41.	Lead		Support the use of updated information to inform the health-based guideline value.	Noted.
42.	Information sheet	BACKGROUND "As mentioned in Section 9.6, some plumbing products used within premises such as residential buildings, hospitals and schools have the potential to leach metals and metalloids into drinking water under certain conditions. This is likely to occur past the point of water supply (i.e. the water meter) as leaching most likely occurs within the plumbing system in-premises."	Terminology switches between chemicals as in the title and metals here. Can a consistent term be used?	Accepted. Updated text for consistency and as appropriate. The information sheet is intended to be expanded with other chemicals over time.
43.	Information sheet	BACKGROUND	Might be helpful to say why 'leaching most likely occurs within the plumbing systems in-premises'.	Accepted. Text amended to clarify.

#	Fact sheet	Relevant section	Feedback received	Action/Response
		"As mentioned in Section 9.6, some plumbing products used within premises such as residential buildings, hospitals and schools have the potential to leach metals and metalloids into drinking water under certain conditions. This is likely to occur past the point of water supply (i.e. the water meter) as leaching most likely occurs within the plumbing system in-premises."		
44.	Information sheet	BACKGROUND "The leaching of lead brass in plumbing has historically received the most attention given the known health effects of lead exposure (see the Lead Fact Sheet and NHMRC 2015)."	Here it mentions lead brass and lead free brass, later refers to ABCB requirements for copper alloy plumbing products, and later silicon brass etc. can this be more consistent?	Accepted. Updated text for consistency and as appropriate to balance with need for plain language.
45.	Information sheet	SAMPLING IN-PREMISES "• Building commissioning – to determine the presence of metals in a building as part of the commissioning process. The 6-hour stagnation (6HS) is the most appropriate methodology."	Are the abbreviations in this section necessary (6HS, RDT, 30MS) in ADWG? I think these terms were used in the enHealth guidance.	Accepted. Text updated.

#	Fact sheet	Relevant section	Feedback received	Action/Response
46.	Information sheet	BACKGROUND	The term metalloids does not seem to be used in ADWG so we are not sure why it is retained here.	No change. Silicon is classed as a metalloid.
47.	Information sheet	REDUCING EXPOSURE TO CHEMICALS LEACHING FROM PLUMBING PRODUCTS *Flushing*	Include following text at end of section: 'Extensive flushing is also advisable towards the end of commissioning of newly constructed or renovated plumbing systems. This is required because plumbing works can leave significant amounts of "swarf" or metal filings within the drinking water pipes. Flushing to remove these needs to be done after aerators or flow restrictors are removed to ensure they are not entrapped within drinking water outlets.'	Accepted.
48.	Information sheet	SAMPLING IN-PREMISES • "demonstrating that a flushing program is not required or confirming that one is required"	For simplicity, amend text to: • 'assessing if a flushing regime is required or not.'	Accepted. Text amended.
49.	Information Sheet	REDUCING EXPOSURE TO CHEMICALS LEACHING FROM PLUMBING PRODUCTS *Flushing* "In other buildings with vulnerable occupants, such as children, infants and pregnant women…"	We have described this above for children and infants….so we need to make this point about other vulnerable populations (such as the elderly and immunocompromised).	Accepted. Text amended.
50.	Information sheet	REVIEW OF BISMUTH, SELENIUM AND SILICON BRASSES	Include reference to this information in the relevant factsheets where available for the reader to seek further information.	Partially accepted. Text updated to provide reference to the relevant fact sheets. References to the Information Sheet is already provided in the

#	Fact sheet	Relevant section	Feedback received	Action/Response
				relevant chemical fact sheets.
51.	Information sheet	SAMPLING IN-PREMISES "*Plumbing systems are site-specific and advice should be sought from the relevant health authority or drinking water regulator before implementing a sampling program. The design and implementation of a water sampling program is complex and careful planning should be undertaken to ensure that meaningful results are generated*".	Sampling internal plumbing requires specific knowledge which health authorities or drinking water regulators may or may not have. If the guidance is not provided in the ADWG then the reference should be made to applicable guidance such as enHealth (other industry guidance) and also inclusive of water agencies and local councils prior to suggesting contacting relevant health authorities or drinking water regulators.	Partially accepted. References are made to enHealth guidance throughout, which has been developed for the Australian context. Text edited to include other water professionals.
52.	Information sheet	TREATMENT "Some in-premises water treatment units, such as filtration or reverse osmosis units, may be effective at removing metals or metalloids from drinking water."	Research shows that in many cases POU filtration systems are not appropriately selected (how to quantify the loading and LRVs for chemical removal?) or maintained resulting in systems underperforming without knowledge of the users. Is it possible to have stronger text which discourages people from using POU filtration in this context given the complexity of validating to demonstrate metal removal in a domestic setting? Elaborate and emphasise the instructions to include aspects such as installation, maintenance, and operation.	Partially accepted. Some edits made to clarify that advice should be sought to determine if treatment is appropriate.
53.	Information sheet	TREATMENT "Manufacturer's instructions should be followed to ensure the filtration units remain effective."	Elaborate and emphasise that instructions includes installation, maintenance and operation. Amend text to:	Accepted. Text amended.

#	Fact sheet	Relevant section	Feedback received	Action/Response
			'Manufacturer's operational and maintenance instructions should be followed to ensure the filtration units remain effective.'	
54.	ADWG edits	9.6 WATER QUALITY ISSUES BEYOND THE POINT OF SUPPLY "This is seen particularly in schools after lengthy holiday breaks, where water to drinking fountains has remained stagnant in pipes."	Could NHMRC consider using 'bubblers/fountains'? I think this is used elsewhere in ADWG. In some regions, one term or the other is commonly used.	Accepted. Text updated.
55.	ADWG edits	9.6 WATER QUALITY ISSUES BEYOND THE POINT OF SUPPLY *Role of building and site owners and managers and plumbing oversight agencies* "A patina on metals and metallic alloys is a coating of various chemical compounds such as oxides, carbonates, sulphides, or sulphates formed on the wetted surface during exposure to water."	Suggest 'sulfide' is used rather than 'sulphide'. This is consistent with the use elsewhere in ADWG (generally!) and the International Union of Pure and Applied Chemistry (IUPAC)	Accepted. Text updated. For consistency, amendments to other sections of the Guidelines have also been proposed.
56.	ADWG edits	6.3 CHEMICAL QUALITY OF DRINKING WATER	Include • generation of disinfection by-products due to interaction between organic chemicals in water and disinfectants like chlorine.	Accepted. Text updated.

#	Fact sheet	Relevant section	Feedback received	Action/Response
57.	ADWG edits	6.3.1 INORGANIC CHEMICALS "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)."	Note: If compliance monitoring only measures freely dissolved fraction, it may be underestimating values for comparison with guideline?	Accepted. Text amended to simplify.
58.	ADWG edits	9.6 WATER QUALITY ISSUES BEYOND THE POINT OF SUPPLY	Consider adding a reference to Section 9.6 in the Lead and Copper factsheets. The individual factsheets currently talk about how lead can be "leaching from household plumbing products" and how "Copper is relatively resistant to corrosion and is used in domestic water supply pipes and fittings" but falls short of mentioning some important themes from 9.6, such as "water quality should be managed up to the point of consumption, usually the customer tap". "Catchment to tap" is appropriately mentioned in the subheadings for some of the microbial factsheets. Consider doing likewise for lead and possibly copper, to make expectations clear.	Partially accepted. Cross references added to fact sheets for Lead and Copper. Approaches to strengthen 'Catchment to tap' risk management message in Section 9.6 for chemicals to be considered following public consultation or as part of the rolling review of the Guidelines.
59.	ADWG edits	9.6 WATER QUALITY ISSUES BEYOND THE POINT OF SUPPLY	Amend sentence as follows: •Elevated water hardness can cause scaling of pipes, and water elements in kettles and hot water services.	Partially accepted. Similar text included.
60.	ADWG edits	9.6 WATER QUALITY ISSUES BEYOND THE POINT OF SUPPLY "Microbial and chemical contamination can be associated with distribution systems in large buildings. This risk increases where large	Note that the volumes do not have to be large for microbial and chemical contamination to occur. In theory, smaller volumes of water are exposed to a proportionally greater area of biofilm/pipe/tank.	Noted. Text updated to remove size of water volume.

#	Fact sheet	Relevant section	Feedback received	Action/Response
		volumes of water are stored for extended periods in on site header tanks…"		
61.	ADWG edits	9.6 WATER QUALITY ISSUES BEYOND THE POINT OF SUPPLY "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."	Note: Not sure if this is the position of plumbing regulators. They will see their responsibility as being to ensure plumbing products are compliant with plumbing regulations and standards and that people licensed under plumbing laws comply with the requirements of their licence. I'm not sure that entails a higher order responsibility for water quality in private plumbing. I suggest getting a plumbing regulator to review this statement.	Noted. Current text has been retained by Committee to emphasise the shared responsibility in the sector to ensure safety. The guidance will be available for review by plumbing agencies during public consultation.
62.	ADWG edits	6.3 CHEMICAL QUALITY OF DRINKING WATER "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."	Remove following text: "including some pesticides". Why specifically mention pesticides, when other organic and inorganic chemicals are of equal concern?	Accepted. Text removed.
63.	ADWG edits	6.3.1 INORGANIC CHEMICALS	The obvious question is why we don't have a Section 6.3.2 Organic chemicals? I get this is related to lead replacements, but the introduction mentions organic chemicals and we allude to them in the dot points above [Section 6.3].	There is an existing Section 6.3.2 Organic Compounds in the Guidelines. It has not been included for review, as there are no proposed edits to that section.

#	Fact sheet	Relevant section	Feedback received	Action/Response
64.	ADWG edits	6.3.1 INORGANIC CHEMICALS "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)."	Amend text as follows: 'Unless otherwise stated, the guideline value refers to the total amount of the substance present, regardless of its form (i.e. dissolved or particulate fraction).' Note: Using dissolved and particulate is consistent with how we reference this in other parts of the ADWG.	Partially accepted. Text updated for consistency and clarification.
65.	ADWG edits	9.6 WATER QUALITY ISSUES BEYOND THE POINT OF SUPPLY "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."	Remove following text: "however". I think the sentence reads better without this word?	Not accepted. Preceding text describes responsibility of water suppliers being at the point of supply to the customer however this paragraph is suggesting that water quality should be managed to the point of consumption.
66.	ADWG edits	9.6 WATER QUALITY ISSUES BEYOND THE POINT OF SUPPLY	Include Water Suppliers in bulleted list. We have a subsection on "role of water suppliers" which clearly outlines some obligations upon them. So it makes sense to include them here.	Accepted. Text updated.
67.	ADWG edits	9.1 INTRODUCTION "Most of the monitoring information in this chapter relates to the operation of reticulated drinking water	The update while covering the metals aspect of plumbing could be enhanced by noting the potential microbial aspects of internal plumbing such as opportunistic pathogens and referring to the relevant locations in Chapter 5.	Noted. Text amended and reference to Chapter 5 added. Any further information about microbial water quality may be

#	Fact sheet	Relevant section	Feedback received	Action/Response
		systems up to the point of supply (usually the water meter). However, water quality may be impacted beyond the point of supply through leaching of substances from plumbing products into drinking water, which may present a potential health risk to consumers at the tap. 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".		considered in a future update.
68.	ADWG edits	9.6 WATER QUALITY ISSUES BEYOND THE POINT OF SUPPLY *Role of water suppliers* "While internal plumbing systems are largely outside of the control of water suppliers, it is reasonable to expect that water suppliers be aware of these issues".	The underlined text is new to the guidelines and should also include reference to health authorities and drinking water regulators as needing to be aware of such issues to ensure completeness as not all water will be supplied by a utility. The department often receives calls from the public regarding internal plumbing issues from community and utility supplies. Furthermore, there is sustained and in some cases growing use of private water in certain residential and school developments.	Partially accepted, noting that the underlined text is not new to the Guidelines. Text amended to clarify.
69.	ADWG edits	9.6 WATER QUALITY ISSUES BEYOND THE POINT OF SUPPLY	Following the new text "in-premises water conditions including microbial water quality" link to the relevant sections in Chapter 5 regarding opportunistic pathogens etc.	Accepted. Text amended.

Table 4. 2024 enHealth comments on the draft guidance (manganese)

#	Fact Sheet	Relevant section	Feedback received	Action/Response
Question 1: Is the draft guidance relevant, accurate and easy to understand?				
1.	-	-	The draft guidance is relevant, accurate and easy to understand and therefore suitable to go to consultation.	-
2.	-	-	Yes	-
Question 2: Do you support the approaches taken to review the evidence and develop the guidance?				
3.	-	-	The approaches taken in the review are supported.	-
4.	-	-	Yes	-
Question 3: Do you have any other comments about implementation or feasibility of the proposed health-based guideline values?				
5.	-	-	Implementation may elicit some feedback during consultation – particularly by water providers that are near the current HBGV. Local regulators will need to work closely with the providers to ensure that suitable transition arrangements are in place for halving the HBGV and what that means for compliance moving forward. This is possibly more a discussion for enHealth WQERP but should be noted.	Noted.
6.	-	-	[There are] many small and remote drinking water supplies, with poor source water quality, operated by small, poorly resourced local governments. Some of these will, from time to time, struggle to achieve the proposed HBGV for manganese. However, as the correct methodology has been used to establish this HBGV, it is defensible and should stand.	Noted.
General comments:				

#	Fact Sheet	Relevant section	Feedback received	Action/Response
7.	ADWG edits	-	The main changes suggested revolve around Mn interfering with the DPD method by overestimating the Cl concentration. I think there is value in making this point in each of the Fact Sheets, rather than just make it once in Information Sheet 1.4 and then cross referencing that in the other Information Sheets.	Accepted. Consequential changes to be made in other fact sheets where relevant.
8.	Manganese	GENERAL DESCRIPTION	With manganese commonly measured across Australia, is there potential to include a typical range for Australian conditions?	Accepted. Additional information will be included if it is made available or identified during public consultation.
9.	Manganese	GENERAL DESCRIPTION "At manganese concentrations above 0.02 mg/L, an increase in consumer complaints is common."	I'm thinking that this is as a result of discolouration, rather than taste and odour? If so, should we say that?	Partially accepted. Text moved to sentence about coating/ooze. EPA has an aesthetic guideline value of 0.05mg/L to limit issues with taste, and precipitates. Text derived from current fact sheet with no reference.
10.	Manganese	GENERAL DESCRIPTION Oxidised forms of manganese (e.g. permanganate) can interfere with the commonly used DPD method for determining chlorine residual, potentially resulting in an overestimation of the chlorine residual (see Information Sheet 1.4 on Chloramines).	Perhaps expand "DPD method" for clarity.	Accepted. Diethyl-phenylenediamine inserted for clarity.
11.	Manganese	GENERAL DESCRIPTION	I've made some comments and changes in the Consequential amendments around this. It appears (at least to me) that we	Accepted. Cross references inserted into other fact

#	Fact Sheet	Relevant section	Feedback received	Action/Response
		Oxidised forms of manganese (e.g. permanganate) can interfere with the commonly used DPD method for determining chlorine residual, potentially resulting in an overestimation of the chlorine residual (see Information Sheet 1.4 on Chloramines).	are referencing around in circles. It is an equally important point to make in all relevant places - rather than just refer back to Information Sheet 1.4. Also see line 7 above	sheets for relevant water treatment chemical fact sheets.
12.	Manganese	TYPICAL VALUES IN AUSTRALIAN DRINKING WATER "In major Australian reticulated drinking water supplies, manganese concentrations have been found up to 0.8 mg/L, with typical concentrations less than 0.03 mg/L. Mean concentrations of manganese in reticulated drinking water supplies measured below 0.03 mg/L across urban and regional Western Australia and in Northern Territory town centres (Water Corporation 2023, Power and Water Corporation 2023)."	Victorian data can be found in some water agency annual water quality reports.	Accepted – this section is not meant to be exhaustive but additional information will be included when it is made available or identified during public consultation. Added: Manganese concentrations measured in drinking water derived from the six major Melbourne storage reservoirs following primary treatment processes were in the range 0.0001–0.0138 mg/L during 2022 (Melbourne Water 2023).
13.	Manganese	TYPICAL VALUES IN AUSTRALIAN DRINKING WATER "In major Australian reticulated drinking water supplies,	Why only NT and WA data? For example, Sydney Water has this on the website https://www.sydneywater.com.au/water-the-environment/how-we-manage-sydneys-water/safe-drinking-water/water-analysis.html	Accepted – this section is not meant to be exhaustive but additional information will be included when it is

#	Fact Sheet	Relevant section	Feedback received	Action/Response
		manganese concentrations have been found up to 0.8 mg/L, with typical concentrations less than 0.03 mg/L. Mean concentrations of manganese in reticulated drinking water supplies measured below 0.03 mg/L across urban and regional Western Australia and in Northern Territory town centres (Water Corporation 2023, Power and Water Corporation 2023)."	As do Hunter Water What's in your water - Hunter Water Additionally, we have looked at the last 10 yrs of data from regional NSW which shows a median of 0.0025mg/L.	made available or identified during public consultation.
14.	Manganese	TREATMENT OF DRINKING WATER "Manganese concentrations in drinking water source waters may be lowered to below 0.05 mg/L by using common water treatment methods, including oxidation/filtration, adsorption/oxidation, softening/ion exchange and biological filtration (see also Section 8.3.5, Health Canada 2019, WHO 2022). Manganese levels below 0.02 mg/L can be achieved with a well operated and optimised system. However, selection of the appropriate treatment for manganese removal depends on the form of manganese present (dissolved or	Is there anything to add on for management in distribution systems? Obviously desirable to limit input into distribution but for example the WHO guidance talks about minimising hydraulic disturbances, stable chemistry and mains cleaning.	Accepted. Additional text inserted to highlight the importance of the distribution system. "Ensuring stable water chemistry, regular maintenance to remove accumulated oxides and minimising physical or hydraulic disturbances of the distribution system are also key to limiting manganese in drinking water."

#	Fact Sheet	Relevant section	Feedback received	Action/Response
		particulate) (Health Canada 2019, WHO 2022)."		
15.	Manganese	MEASUREMENT "The manganese concentration in drinking water can be determined using inductively coupled plasma atomic emission spectroscopy, inductively coupled plasma mass spectrometry and graphite furnace atomic absorption spectroscopy with detection limits ranging between 0.005–50 µg/L (APHA Method 3500-Mn, Health Canada 2019, WHO 2021, USEPA 2024b)."	In all other sections, we use mg/L. We now introduce ug/L. Should it be constant?	Not accepted. Values kept the same. We could use <0.05mg/L rather than the range but this does not reflect the sensitivity of these methods nor fit with the recommendation to aim for <0.02mg/L. At lower concentrations in other fact sheets we have changed the units to ug/L where required.

Appendix C – Declarations of interest

The declarations of interest of Committee and Working Group members at the time of their involvement in the development of the guidance are listed in the tables below.

Consideration of the declarations of interests of members of the Water Quality Advisory Committee during the period 2018-2021 were undertaken according to NHMRC committee policy at the time.

2018-2021 Water Quality Advisory Committee

Name/Position	Area of Expertise	Declaration of Interest
Professor Frederic Leusch (Chair) School of Environment and Science, Griffith University	Environmental Toxicology; Chemical pollutants in the environment; Endocrine disruption; Bioanalytical tools in water quality assessment; Chemical risk assessment and guideline development.	• Deputy Head (Research), School of Environment and Science • Associate Editor (Toxicology) for Environmental Science and Technology (2020-present) • Associate Editor (environmental toxicology) for Chemosphere 2014 – 2018 • Appointments: Health and Environmental Sciences Institute –Animal Alternatives for EDC Testing Workgroup 2014 – present; Project Review Team – Water Research Australia 2012 – present; Board Member – SETAC 2015 – present. • Member of: Australasian College of Toxicology and Risk Assessment; International Water Association; Society of Environmental Toxicology and Chemistry. • Conference organisation: Chair – SETAC Australasia Conference 2012; Co-Chair: Micro Pool & Ecohazard 2011; Organising Committee: EmCon & WiOW 2016 – Emerging Contaminants and Micropollutants in the Environment; SETAC AP 2014; SETAC Australasia 2013; Discussion Leader – Disinfection By-Products Gordon Research Conference 2015. • Committees: Chair of Steering Committee – Bioanalytical Risk Assessment Validation and Experimentation – Australian Water Recycling of Excellence 2015 – present; NHMRC's Fluoride Reference Group 2014 – 2017; European Commission Seventh Framework Programme – Demonstration of Promising Technologies to Address Emerging Pollutants in Water and Waste Water 2014 – 2015; Water Research Foundation – Screening Endocrine Activity of Disinfection By-Products 2010 – 2014.

Name/Position	Area of Expertise	Declaration of Interest
		• Involved in the Commonwealth Games Independent Expert Panel. • Has provided expert advice to Californian and Australian water utilities on recycled water quality and micropollutants of emerging concern. • Published numerous research papers, conference publications, reports and book chapters. • Presentations at international and national conferences, seminars and workshops. • ARC Linkage grants include many water utilities in Australia (including Water Quality Research Australia).
Ms Miranda Cumpston Monash University and University of Newcastle	Evidence-based public health and systematic review.	• As part of previous role with the Australian Clinical Trials Alliance undertook activities in collaboration with NHMRC and other partners, including public advocacy in relation to the conduct and funding of clinical trials in Australia. • Editor at Cochrane Public Health, University of Newcastle, which receives infrastructure funding from NHMRC. • Editor of *Cochrane Handbook for Systematic Reviews of Interventions* and author of other publications that advocate for the use of systematic reviews in policy. • Received Australian Government Research Training Program (RTP) Scholarship to undertake a PhD in evidence synthesis methods at the Research Methodology Division, School of Public Health and Preventive Medicine, Monash University. • Employed by NHMRC between April and June 2018, contributing to the development of the NHMRC *Guidelines for Guidelines*. • Publications of numerous journal articles. • Guest lectures on evidence synthesis and clinical practice guideline development to Melbourne School of Professional and Continuing Education, University of Melbourne (various courses) in 2018 and 2019.
Dr David Cunliffe South Australian Department for Health and Wellbeing	Water regulator, microbiology, risk assessment.	• Principal water quality specialist with the SA Department for Health and Wellbeing. A regulator with over 35 years of experience dealing with public health aspects of drinking water, recycled water and recreational water. • Contributed to a range of national and international guidelines on drinking water

Name/Position	Area of Expertise	Declaration of Interest
		quality, safe use of recycled water and recreational water quality. • Member of the NHMRC/ARMCANZ Drinking Water Review Coordinating Committee formed in 1998; later a member and then chair of the Water Quality Advisory Committee until the end of 2015. Chair of the working group that developed the Framework for Management of Drinking Water Quality. Member of the Joint Steering Committee for the development of the Australian Guidelines for Water Recycling and chair of the Health Risk and Drinking Water Augmentation working groups. • Member of WHO Water Quality Committees since 2001 and current chair of the WHO Drinking-Water Coordinating Committee. Attendance of meetings and associated expert working groups (e.g toxic cyanobacteria). Attendance at meetings on recreational use of water. Contributed to the 2nd, 3rd and 4th editions of the Guidelines for Drinking Water Quality and the Guidelines for Safe Use of Wastewater, Excreta and Greywater. Lead editor and scientific adviser for WHO texts on "Potable Reuse", "Water Safety in Buildings" and "Water Safety in Distribution Systems". Contributed to WHO texts on "Developing Drinking-water Quality Regulations and Standards" and "Legionella and the Prevention of Legionellosis". • Member of international expert panels on drinking water quality in Singapore and Hong Kong. • Published on drinking water quality, recycled water, desalination, and rainwater quality.
Mr Cameron Dalgleish Tasmanian Department of Health	Environmental science, water quality and risk management, auditing, public health.	• Health regulator for drinking water safety in Tasmania; administering legislation, policy and guidelines. Cover both drinking water quality and fluoridation with a working understanding of the implementation of the ADWG framework. • An environmental scientist specialising in water chemistry with 20 years' experience in the water industry. Previously worked across construction, natural resource conservation, environmental management and as a health regulator. • Member of the enHealth Water Quality Expert Reference Panel and the National Recycled Water Regulators Forum.

Name/Position	Area of Expertise	Declaration of Interest
		• Secretariat of the Tasmanian Fluoridation Committee. • Publication of journal articles, reports, fact sheets, guidelines and presentations at national conferences, seminars and workshops. • Public Servant: State Water Officer, Department of Health Tasmania. Areas of expertise: environmental science, water quality and chemistry, risk management, auditing, public health.
Dr Dan Deere Independent Consultant Director Water Futures. Visiting Fellow; Water Futures, The University of New South Wales	Water Quality and Risk Management, water and recycled water auditing.	• Consultant – Water Futures Visiting Fellow – UNSW • Current projects for: University of Technology Institute for Sustainable Futures 2019 – present; Monash Medical School (DHHS): 2019 – present; University of Bristol, Kathmandu University and Haramaya University (funded by UK Aid): 2020-present; University of Adelaide, (for Seqwater): 2019 – present; University of Adelaide and Australis Consulting (for Central Coast Council): 2019 – present; University of New South Wales, Monash University and Natural Logic (for Water Research Australia): 2019 – present; New Zealand Ministry of Health and Department of Internal Affairs: 2019 – present; Hastings District Council and New Zealand Ministry District Health Board: 2017 – present; Hong Kong Water Supplies Department: 2017 – present; NT Government (Power Water with Department of Local Government, Housing and Community and Department of Health): 2018 – present; NSW Health: 2019 – present; Department of Health and Human Services, EPA and Department of Environment, Land, Water and Planning: 2019 – present; Department of Health and Human Services, EPA and Department of Environment, Land, Water and Planning: 2019 – present; University of Queensland: 2009 – present. • Current major unfunded projects/activities: World Health Organization Guidelines for Safe Recreational Water Environments Working Group; National Health and Medical Research Council Guidelines for Managing Risks in Recreational Water, Water Quality Advisory Committee; COVID-19 technical support for multiple agencies in Australia and internationally on an as needs basis relating to general microbiology and WASH aspects. This to date has been in the US, UK, China, HK, Australia and NZ.

Name/Position	Area of Expertise	Declaration of Interest
		• Additional minor funded activities past and present include peer reviews, training, workshop facilitation, regulatory audits of water suppliers for health departments, contributions to research projects and specific technical assessments and validation, with the work mostly related to microbial pathogens. • Occasionally undertakes work for members of the Australian Water Industry as a consultant. This includes Health Departments, Water Agencies and Water Utilities and related to water quality risk assessment and management and other aspects of water quality science. This also involves Water Research Australia: Drinking water catchment source assessment tool; Hong Kong Development Bureau and Department of Health: assessment of risks from using seawater for non-potable uses; NSW Health: support for councils to implement the ADWG Framework; Power Water (Northern Territory): Catchment source water assessments to identify pollution sources; Vic DHHS: Drinking water supply risk management plan regulatory audits for water utilities (funded by the utility but undertaken for DHHS); SA Health/SA Water: Drinking water supply risk management plan regulatory audit for SA Water; Queensland Health: Advising Qld councils on implementing Health-based Targets; NSW EPA and Sydney Water: QMRA relating to biosolids application as part of guideline revision; Vic EPA: QMRA relating to recreational water guidelines; NSW IPART: Drinking water supply risk management plan regulatory audits for water utilities (funded by the utility or IPART but undertaken for IPART); WHO: Western Pacific Regional Office Water Safety Plan Training of Trainers Program for AusAID (DFAT) and UK AID. • Occasionally provides expert witness statements in court for the interpretation of the Australian Drinking Water Guidelines or Guidelines for Managing Risks in Recreational Water in relation to water quality protection. • Member of Seqwater Water Security Program - Independent Review Panel, NSW Health Cryptosporidium and Giardia Expert Panel, the Australian Water Association, the International Water Association and Water Research Australia. • Publications include numerous journals and technical reports and presented at international and national conferences, seminars, webinars

Name/Position	Area of Expertise	Declaration of Interest
		and workshops. Focus is on providing practical guidance founded in objective, best available evidence for water quality management.
Professor Cynthia Joll Professor, Curtin Water Quality Research Centre, Curtin University	Analytical chemist with a focus on disinfection by-products, both in terms of formation, detection and analysis of the chemicals.	• 2006 – 2018, Deputy Director, Curtin Water Quality Research Centre, Curtin University. 2019 – Present, Professor within the Curtin Water Quality Research Group, Curtin University. The Curtin Water Quality Research Centre is a Strategic Research Alliance with the Water Corporation of WA. Curtin University is also a research member of Water Research Australia. • Chief Investigator on a current ARC Linkage project on nitrogen compounds in wastewater treatment. Chief Investigator on past ARC Linkage projects on disinfection by-products in drinking water systems with partner organisations Water Corporation of WA and Water Research Australia. Future applications to ARC for research support. • Publications of numerous journal articles, book chapters and reports.
Professor Stuart Khan Water Research Centre, The University of New South Wales Fellow, Australian Academy of Technological Sciences and Engineering (FTSE)	Trace Chemical Contaminants in Water; Risk Assessment and Risk Management; Environmental Engineer.	• Lectures at the University of New South Wales on topics closely related to the activities of the Water Quality Advisory Committee and the Recreational Water Quality Advisory Committee including water and wastewater quality and analysis. • Works closely with many Australian and international water industry participants including water utilities, health regulators, environment regulators and private consultants. • Committee/Advisory member of: Sydney Independent Metropolitan Water Advisory Panel; WHO – Water Quality and Technical Advisory Group 2015 – present; Water Quality Research Australia – Project Quality Review Team 2012 – present; U.S. WateReuse – Technical Advisory Committee 2015 – 2017; Gold Coast Commonwealth Games Independent Expert Panel – Water Quality and Monitoring Programme 2016 – present; the National Water Grid Advisory Body 2020 – present (The Advisory Body provides independent expert advice to the Australian Government via the Deputy Prime Minister on specific water infrastructure policy, projects and investment priorities).

Name/Position	Area of Expertise	Declaration of Interest
		• Member of: Australian Water Association; International Water Association; Engineers Australia. • Honorary (unpaid) role as an adviser to the Parramatta River Catchment Group. • Past Committee/Advisory member of: U.S. WateReuse Foundation – Project Advisory Committee 2010 – 2014; Australian Water Recycling Centre of Excellence – Project Advisory Committee 2011 – 2014; CSIRO and NSW Environmental Trust – Project Advisory Committee 2010 – 2013; South East Queensland Urban Water Security Research Alliance – Project Advisory Committee – Purified Recycled Water Project 2008 – 2012. • Consultant: undertook work for members of the Australian Water Industry in relation to water quality. • Provided expert opinion to Water Research Australia on PFAS chemicals. This includes contribution to a current water industry fact-sheet on these chemicals and their relevance to the water industry. In the past, made comments to the media regarding the safety and risks associated with PFAS in drinking water. • Journal Editorships: Associate Editor – Environmental Science – Water Research and Technology; Journal of Water Supply – Research Technology. • Participation in national and international academic and industry conferences. • Publication of numerous journal articles, reports and book chapters; also presentations at international and national conferences, seminars and workshops. • Recipient of research grants from government and non-government agencies – including Australian Research Council and Water Research Australia. Applications for NHMRC funding are much less frequent, but not excluded.
Associate Professor Susan Petterson Associate Professor, School of Medicine, Griffith University Director, Water & Health Pty Ltd	Quantitative Microbial Risk Assessment Specialist and risk assessment software development.	• Associate Professor at School of Medicine, Griffith University. • Director of Water & Health Pty Ltd • Editor: Journal of Health and Water (IWA Publishing) • Consultant to: Viega Plumbing on opportunistic pathogens; the City of Edmonton, Canada – on recreational water; expert testimony for AGL

Name/Position	Area of Expertise	Declaration of Interest
Editor, Journal of Water and Health		Macquarie on opportunistic pathogens; NSW Health – in drinking water QMRA; Queensland Urban Utilities – applying QMRA to assess overflow impacts on recreational sites. • Advisor for WHO Water Sanitation Hygiene and Health on risk assessment and microbial aspects in water. • Member of the independent peer review panel (human health) for Sydney Water. • Member of Sydney Independent Metropolitan Water Advisory Panel • Peer Review of QMRA undertaken for recreational water quality at Hunter Beaches for Hunter Water. • Current projects for: Global Water Pathogens Project; Public Health Agency of Sweden 2012 – present; Sydney Water Corporation 2012 – present; NSW Health 2012 – present; WHO 2009 – present. • Past projects for: Government of Alberta, Canada 2013 – 2014; INTARES EU 2011 – 2014; Water Research Australia 2011 – 2013; Swedish Water and Wastewater Association – Stockholm Water Ltd 2011. • Publications on numerous journals and reports; also presentations at international and national conferences, seminars and workshops. • IWES course presentation.
Professor Craig Simmons Fellow, Australian Academy of Technological Sciences and Engineering (FTSE) Executive Director for Maths, Chemistry, Physics and Earth Sciences at the Australian Research Council (secondment). National Centre for Groundwater Research and Training, School of the Environment, Flinders University	Groundwater Hydrology, Hydrological, Environmental, Earth and Applied Engineering Sciences.	• Foundation Director at the National Centre for Groundwater Research and Training • Executive Director at the Australian Research Council • Matthew Flinders Distinguished Professor of Hydrogeology and Schultz Chair of the Environment – Flinders University; Fellow of the Australian Academy of Technological Sciences & Engineering; Adjunct Professor – The University of Western Australia. • Committee member of: Alternate Deputy Chair Statutory Independent Scientific Committee (IESC) on Coal Seam Gas and Large Coal Mining Development; Chair – IESC Research Subcommittee; Deputy Chair of the ATSE's Water Forum; Chair – Roundtable for Oil and Gas Projects in South Australia; Chair, Alligator Rivers Region Technical Committee; Member – Research Advisory Committee, Goyder Institute for Water Research South Australia; Member – Engineering and Medicine Roundtable on Unconventional Hydrocarbon Development, US National Academies of

Name/Position	Area of Expertise	Declaration of Interest
Adjunct Professor, The University of Western Australia		Sciences; Member – Agency reference Group, Office of Groundwater Impact Assessment, QLD; Member – Steering Committee, SA NRM research and Innovation Network. • Member of: Australian Institute of Company Directors; National Groundwater Association of the U.S.A; International Association of Hydrogeologists; American Geophysical Union; Geological Society of America; Hydrological Society of South Australia. • Editorial boards: Australian Journal of Water Resources; International Journal of Water Conservation Science and Engineering; International Journal of Environmental Modeling and Assessment; Groundwater; Journal of Hydrology; Vadose Zone Journal. • Publications of numerous journal articles, book chapters and reports; presentations at international and national conferences, seminars and workshops. • Honorary Professor Australian National University.
Ms Carolyn Stanford (Consumer Representative) Stanford Marketing	Marketing and Communication	• Consultancy fees to Stanford Marketing from Goulburn-Murray Rural WaterCorp for marketing and communication services. • Development of Goulburn – Murray Water publications. • Development of various guidelines, standards, educational material or fact sheets for Coliban Water 1999 – 2005.
Dr Katrina Wall Water Unit Health Protection NSW Health	Health Regulation, water quality risk management and environmental microbiologist.	• Employed by NSW Health as Senior Project Officer in the Drinking Water Risk Management Water Unit, Environmental Health Branch since 2008. Provide water quality advice, policy and regulation for NSW. • Represented NSW on the enHealth Water Quality Expert Reference Panel 2016-2018, providing advice and national guidance on water quality and public health. • Represents NSW Health on the NSW Carp Advisory Group, 2017-current, provides advice and NSW policy position to the National Carp Control Program. • NSW sewage surveillance for SARS-CoV-2 steering committee member. • Corporate member of the International Water Association and WaterRA including participation in project advisory committees, and personal member of the Australian Water Association.

Name/Position	Area of Expertise	Declaration of Interest
		• Member of the Project Advisory Committee to Water Research Australia project 1109 Health Based Targets guidance. • Published journal articles conference proceedings and reports, presented at international and national conferences, seminars and workshops. • Development of various guidelines, factsheets and educational materials on water quality. • PhD supported by AWWARF project 2618 Water quality improvements during ASR as part of the Bolivar ASR Project.
Dr Nick Fletcher (Observer) Food Standards Australia New Zealand	Toxicology and risk assessment.	• Member of: Joint FAO/WHO Expert Committee on Food Additives (JECFA) advisory panel; New Zealand Environmental Protection Agency Hazardous Substances and New Organisms Committee. • Manager Risk Assessment Chemical Safety and Nutrition, Food Standards Australia New Zealand. • Senior Associate (Toxicology) Coffey Environments 2012-2013.
Ms Amy Lea (Observer) Department of Agriculture, Water and the Environment	National Water Policy and Reform.	• Australian Government national water quality policy.
Mr Adam Lovell (Observer) Water Services Association of Australia (WSAA)	Peak industry body representing the urban water industry.	• Water Services Association of Australia (WSAA) – Executive Director. • Global Water Research Coalition (GWRC) – Board Chair. The GWRC is a non-profit organisation that serves as a focal point for the global collaboration for research planning and execution on water and wastewater related issues.
Mr Marcus Walters (Observer until 2020) Department of Agriculture, Water and the Environment	National Water Policy and Reform.	• No interests declared

2022-2025 Water Quality Advisory Committee (declared interests as of May 2024)

Name/Position	Disclosed Interests
Professor Nicholas J. Ashbolt **(Chair)** Cooperative Research Centre for Solving Antimicrobial Resistance in Agribusiness, Food and Environments, University of South Australia.	• Executive Dean, Faculty of Science and Environment, Southern Cross University (2019-2023). • WHO Technical Advisory Group on Water Quality and Health (since 2015-current), for input into drinking, recreational and reuse guidance documents and microbial pathogen performance of on-site drinking water treatment devices. • Water Research Foundation (WRF) Academic Advisory Committee (2016-2019) and Project Advisor Committee (PAC, 2019-2022) for WRF 5040, Successful Implementation of Decentralized Reuse and Treatment Systems. • National Water Research Institute (NWRI) expert panel member (2015-2021) on various non-potable water risk management and regulation projects. • Editor in Chief voluntary role as part of his professional contributions as a Fellow of the International Water Association. • Led water microbiology research into premise plumbing pathogens (e.g. Legionella pneumophila, Pseudomonas aeruginosa, non-tuberculous mycobacteria) and the role of free-living amoeba hosts that also supported viable human enteric viruses through treatment processes and environmental dissemination. • Numerous national and international research grants and collaborations. • Has consulted on wastewater reuse. • Royalties from patents managed by Macquarie University, Australia. • Partner works for company Water^3. • Senior editor for HealthStream, a quarterly newsletter from Water Research Australia (WaterRA) that summarizes international literature relevant to the drinking water industry and notes recent outbreaks or investigations. • Travel, accommodation and workshop paid by SUEZ CIRSEE (Paris) for role as a mentor for their Health and Environment postgraduate conference, Cannes, France June 26-28, 2023 and technical advisory team with four other invited senior academics across England, France and Australia.
Dr David Cunliffe Principal Water Quality Adviser Health Regulation and Protection SA Health	• Provide specialist advice and policy on public health aspects of water quality including management and provision of drinking water, management and use of recycled water and use of recreational waters. • Contribution to WHO Drinking Water Guidelines leading to publication of background documents (e.g on toxic cyanobacteria in 2021), specialist texts and two addenda to the 4th edition of the guidelines. • Occasional invitations to provide keynote presentations at international meetings. • Published a number of scientific research journal articles. • Contributed to: WHO (2021) Water, sanitation, hygiene, and waste management for SARS-CoV-2, the virus that causes COVID-19, NRMMC/EPHC/NHMRC (2008) Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 2).

Name/Position	Disclosed Interests
	Augmentation of Drinking Water Supplies, enHealth Guidance on the Use of Rainwater Tanks and Numerous fact sheets and guidance documents for the SA Department for Health and Wellbeing on drinking water and recreational waters. • Membership of the program committees including for the Singapore International Water Week and Australian Water Association Annual Conference OzWater. • Membership of the International Water Association and Australian Water Association. • Membership of the Hong Kong Drinking Water Safety Advisory Committee from 2018. • Membership of Guideline Development Group WHO Guidelines on Recreational Water Quality Volume 1 Coastal and Fresh Water (1998-2021) • Chair of the enHealth Water Quality Expert Reference Panel since 2017. • Chair of the External Audit Panel Singapore Public Utilities Board since 2020. • Chair of the WHO Drinking Water Guideline Coordinating Committee.
Mr Cameron Dalgleish State Water Officer Tasmanian Department of Health	• Health regulator for drinking water safety in Tasmania; administering legislation, policy and guidelines for both drinking water quality and fluoridation. A working understanding of the implementation of the ADWG framework. • An environmental scientist specialising in water chemistry with over 20 years' experience in the water industry. Previously worked across construction, natural resource conservation, environmental management and as a health regulator. • Appointments: Member of the enHealth Water Quality Expert Reference Panel, the National Recycled Water Regulators Forum and the Australian Water Association. Secretariat of the Tasmanian Fluoridation Committee. • Department of Health Tasmania Member Representative to Water Research Australia. • Has published journal articles, reports, fact sheets, guidelines and presentations at national conferences, seminars and workshops. • Public Servant: State Water Officer, Department of Health Tasmania. • Project contributor for the development of Operator Competencies in the water industry and development of a WaterVal granular media filter validation protocol, both coordinated by Water Research Australia. • Areas of expertise: Environmental science, water quality and chemistry, risk management, auditing, public health. • Holds stock market investments, and partner is a joint investor in managed fund investments. Neither have influence in the selection of shares purchased on their behalf.
Professor Cynthia Joll	• Previously Deputy Director, Curtin Water Quality Research Centre, Curtin University. The Curtin Water Quality Research Centre was a

Name/Position	Disclosed Interests
Discipline Lead of Chemistry Curtin University	Strategic Research Alliance with the Water Corporation of WA. Member representative for Curtin University to Water Research Australia. Currently, Professor and Leader of the Curtin Water Quality Research Group. • Chief Investigator on past ARC Linkage projects on disinfection by-products in drinking water systems, and other drinking water and wastewater projects, with partner organisations Water Corporation of WA and Water Research Australia. • Current, past and future projects funded by water utilities on wastewater treatment, water recycling, and drinking water treatment and distribution, including formation of disinfection by-products and analysis of their concentrations in drinking water distribution systems. • Published numerous research papers, conference publications, reports, books and book chapters on wastewater treatment, water recycling, source water quality and drinking water treatment and distribution, including disinfection by-products. • Participation in national and international academic and industry conferences. • Current, past and future projects funded by industry partners, government (e.g. NESP) and CSIRO on PFAS in drinking waters, wastewaters, water recycling and manufactured and waste products (e.g. for recycling purposes). • Lectures at Curtin University on environmental chemistry, water chemistry and analytical chemistry. • Travel support to attend research meetings of Water Research Australia where topics such as drinking water treatment and disinfection by-products have been discussed. • Current, past and future projects funded by the water industry relating to corrosion and metal concentrations in drinking water distribution systems.
Professor Frederic Leusch (Member from September 2023) School of Environment and Science, Griffith University	• Several consultancies funded by water industry, specifically on contaminants of emerging concern. • ARC Linkage grants include many water utilities in Australia (including Water Research Australia). • Previous member of the Project Review Team for Water Research Australia, which reviews research projects submitted for Water RA funding and provide advice on suitability to Water RA's research agenda. • Received travel support from Water Research Australia to present on research supported by Water RA at their annual research conference. • Teaches on water quality issues at Griffith University and has given lectures at various institutions on water quality issues and various drinking water guidelines. • Previously involved on the Commonwealth Games Independent Expert Panel on water quality, providing advice on water quality and monitoring programme for the 2018 Commonwealth Games. • Many publications on water quality, all published in peer-reviewed journals.

Name/Position	Disclosed Interests
	• Independent Advisory Panel Member in the Faure New Water Scheme, Cape Town, South Africa.
Mr Peter Rogers Water and public health expert	• Former Principal Policy Development Officer – Water and Wastewater Portfolio, Northern Territory Department of Health.
Ms Nicola Slavin (Member from October 2022) Principal Policy Officer Northern Territory Department of Health	• Northern Territory representative on enHealth Water Quality Expert Reference Panel and the National Recycled Water Regulators Subgroup. • Northern Territory representative on enHealth Expert Reference Panel on Aboriginal and Torres Strait Islander Environmental Health.
Dr Bala Vigneswaran Water and public health expert Department of Climate Change Energy the Environment and Water	• Previously served in New South Wales regional councils for over five years in positions concerning water resources, water treatment processes and system compliance.
Associate Professor Harriet Whiley Associate Professor in Environmental Health Flinders University	• Holds an indirect, non-pecuniary interest through my role as SA Branch Committee Member for the Australian Water Association (2021-2022). • Holds an indirect financial interest through my ongoing research collaborations with Enware, a manufacturer and distributer of commercial and industrial plumbing products. • Flinders University representative for Water Research Australia. • Numerous past, present and current research projects on water quality which have received both grant and industry funding. This includes research on biofilms, opportunistic pathogens, rainwater, plumbing materials and risk management approaches. • Has published in academic journals and industry magazines on topics such as lead and water quality risks. • Has presented at academic and industry conferences and workshops. • Holds an indirect, non-pecuniary interest through her role on the Legionella Management Advisory Group. • Deputy Director of the ARC ITTC for Biofilm Research & Innovation.
Ms Yulia Cuthbertson (Observer from December 2023) Department of Climate Change, Energy, the	• Represents interests of the Department of Climate Change, Energy, the Environment and Water and the Water Quality team from the National Strategies and Assessments section of the Water Policy Division in particular.

Name/Position	Disclosed Interests
Environment and Water	
Dr Nobheetha Jayasekara (Observer from May 2023) Australian Industrial Chemicals Introduction Scheme	• No interests declared.
Mr Laurence Wilson (Observer) National Indigenous Australians Agency	• No interests declared.
Dr Kerry Nugent (Observer until December 2022) Australian Industrial Chemicals Introduction Scheme	• Member of Government standard setting committee
Mr Adam Lovell (Observer until December 2023) Water Services Association of Australia (WSAA)	• Water Services Association of Australia (WSAA) - Executive Director • Peak industry body representing the urban water industry • Global Water Research Coalition (GWRC) – Board Chair • The GWRC is a non-profit organisation that serves as a focal point for the global collaboration for research planning and execution on water and wastewater related issues.
Dr Sonia Colville (Observer until December 2023) Department of Climate Change, Energy, the Environment and Water	• No interests declared.