Water Quality, Nitrates and Health Policy Statement

Public Health Association members are calling for urgent action to protect the mauri and sustainability of Aotearoa New Zealand's drinking water sources. A stronger, long-term health approach is needed to protect the well-being of people and their environment. Public health policy must move to protect water sources from contaminants such as nitrates and ensure kaitiaki can monitor for health effects on people and their environments.

Overview

This policy position statement highlights the relationship between water quality and health outcomes. Access to safe drinking-water is essential to health, acknowledges indigenous relationship with natural resources and is a component of effective policy for health protection and promotion. Nitrate contamination impacts life-sustaining mauri of water and the public health principles protecting health in Aotearoa New Zealand. With management of the country's 'three waters' in transition, it is timely to add a public health focus to help protect communities from degraded drinking water sources and reverse processes that disrupt mauri or life-sustaining capacities.

Adverse health outcomes may occur at concentrations of nitrate in drinking water considerably below 50 mg/L, the level currently permitted as determined by World Health Organization (WHO) Guideline Value[1] and 'Maximum Acceptable Value' (MAV) of the Drinking-water Standards for New Zealand.[2] Health outcomes for which associations have been shown include bowel cancer,[3,4] breast cancer[30], ovarian cancer[30], preterm birth[5, 31], congenital abnormalities[6, 31] and paediatric cancer[32]. Widespread nitrate contamination of New Zealand's groundwater creates an urgent case for robust policy to decrease permitted nitrate levels in drinking water and re-orient the system that enabled it.

Integrating public health measures with an indigenous long-term view, a proactive precautionary approach is advocated to recognise water as a life-sustaining resource for future generations.

Background

Our Relationship with Water

Safe drinking water is a fundamental human right, essential to all life and a key element of United Nations 2030 Sustainable Development Goals.[7,8] Water contamination in Aotearoa New Zealand has had severe consequences for human health,[9] prompting the focus of increased regulatory, financial and cultural resource to water reforms. Māori, as Tiriti o Waitangi partners, have a traditional relationship with water as a taonga, with rights of protection and kaitiakitanga reflected in the transformation of water law and policy.[10]

Special Interest Group or Policy Sponsor		*Dr Gayle Souter- Brown, Chris Webber, Dr Tim Chambers* (Peer reviewed by Dr Jörg Schullehner, 22.02.2022)	
Date ratified by AGM	9/12/2022	**Date to be reviewed**	2025 Policy Cycle

Guiding Frameworks

Te Mana o te Wai is central to Government's Essential Freshwater policies and regulations, enforced through The National Policy Statement for Freshwater Management 2020.[11] This firstly protects the life-supporting capacity of the water, then provides for human health needs, with new requirements to apply a Māori lens to decision-making on freshwater.[11] Te Mana o Te Wai highlights the direct connection between the health of water bodies and the outcomes that support physical well-being, mental and emotional well-being, social well- being, and spiritual well-being, Hauora.[10] Restoring the mauri of water from the degradation of post-colonial activities (including industrialised agriculture) supports a healthy relationship with water and access to safe drinking water.

Action is required within current water reforms to retain a public health focus, such as the ability to track drinking water qualities and impacts on health outcomes. With the transfer of public health drinking water records to the new water authority Taumata Arowai,[12] incorporation of public health priorities for researching and tracking health outcomes related to water quality and contributing environments is urgent.

Nitrate, ecological impacts and scale of pollution

Nitrate is one of the most common drinking water contaminants in Aotearoa New Zealand, largely driven by agricultural activity (nitrogen fertiliser application and livestock waste).[13] Nitrate pollution of freshwater poses an intergenerational challenge due to the extent of the pollution, the lag times to cleanse freshwater sources and the cost of treatment. Between 2014-2018, 44% of the groundwater sites routinely monitored by Ministry for Environment showed nitrate levels above natural levels (i.e. anthropogenic pollution), with 38% of sites worse than 2009-2018, despite environmental regulations.[14] One study of 34 Aotearoa New Zealand water catchments estimated the median lag time was 4.5 years, with some lag times being several decades.[15] Thus, in many areas the peak pollution from agricultural intensification has yet to present in our water bodies, while interventions introduced today may not have noticeable impacts for years. Once a drinking water supply is contaminated with nitrate it is costly and difficult to remove. A recent cost estimate for a nitrate treatment system for Christchurch's water supply was $1,507 million (based on a ~4 mg/L nitrate level), including an estimated $24 million annual operating cost.[16]

Nitrate and direct health impacts

The current regulatory limit for nitrate in drinking water, 50 mg/L, was established to prevent cases of infantile methaemoglobinemia "Blue Baby Syndrome."[1,2,] caused by mixing infant formula with contaminated water, but other health effects were not considered[33]. Adverse infant health outcomes are also linked with maternal exposure to nitrate. Importantly, increased risk of preterm birth[5, 31] and congenital abnormalities[6], impacting across the life course, are seen well below the current MAV.

Recent experimental,[18] epidemiological[19,20] and genetic [18,21-23] evidence also implicates nitrate in drinking water in the development of adult cancers, including bowel cancer.[24] Nitrate is classified as a probable human carcinogen (class 2A).[24] In the largest study, increased risk of bowel cancer was observed at nitrate levels as low as 3.8 mg/L.[4] Note: The high levels of antioxidants in vegetables (the main source of dietary nitrate) helps explain why we do not see an adverse relationship between nitrate in vegetables and any cancers.[24] Thus, this policy statement follows the International Agency for Research on Cancer recommendations to assess nitrate from dietary sources and drinking water separately.[24]

Despite increasing nitrate levels in groundwater nationally, most registered water supplies in Aotearoa New Zealand presently have low levels of nitrate.[25] However, some unregistered supplies, particularly

wells in Canterbury, Nelson / Marlborough and Waikato, have very high nitrate levels.[25] Current estimates suggest that 800,000 New Zealand adults consume water with nitrate levels above the threshold (3.8 mg/L) observed for increased risk of bowel cancer. [25,26] Concerningly, under current rural landuse practice, nationally, trends for nitrate pollution of groundwater show nitrate levels in drinking water are likely to increase[14]. Similarly, nitrate levels in major municipal water supplies are predicted to increase.[27] For example, nitrate levels in Canterbury's aquifers supplying Christchurch City are predicted to increase to 13-33 mg/L if current land use practices persist.[27]

Direct health implications of nitrate in drinking water requires further research to establish the complete risk profile. [28,29] However, recent, robust evidence from interdisciplinary research across several health outcomes, the considerable lag time to effect and the potential scale of the problem of nitrate pollution, support recommendation of a proactive precautionary approach.

The PHA supports:

- a proactive approach
- establishment of a national database for water quality testing, monitoring and record keeping facilitating ongoing research, surveillance and kaitiakitanga.
- development of policies that prioritise restoring the health of the water (Te Mana o te Wai) with sustainable approaches to caring for water recognising its impact on health
- application of the precautionary principle.

PHA actions to support this policy:

- Keep members informed of relevant research, key policy/legislative developments, and consultations
- Influence local and central government policymaking through submissions and participation in policy development forums
- Strengthen relationships with kaitiaki Māori, researchers, aligned advocacy groups, and policy officials and decision makers at local, regional and national levels.

References

1. World Health Organization. *Guidelines for drinking-water quality: fourth edition incorporating the first addendum.* Geneva (CHE)2017. Accessed 11 Aug 2020. https://apps.who.int/iris/bitstream/handle/10665/254637/9789241549950-eng.pdf;jsessionid=653DBF3E25683F182CA7C095E5F61A04?sequence=1.
2. Ministry of Health. *Drinking-Water Standards for New Zealand 2005 (revised 2018).* Wellington (NZL): Ministry of Health;2018. Accessed 26 Jun 2020. https://www.health.govt.nz/system/files/documents/publications/dwsnz-2005-revised-mar2019.pdf.

3. Espejo-Herrera N, Gràcia-Lavedan E, Boldo E, Aragonés N, Pérez-Gómez B, Pollán M *et al.* Colorectal cancer risk and nitrate exposure through drinking water and diet. *Internation Journal of Cancer* 2016;139(2):334-346. https://doi.org/10.1002/ijc.30083

4. Schullehner J, Hansen B, Thygesen M, Pedersen CB, Sigsgaard T. Nitrate in drinking water and colorectal cancer risk: A nationwide population-based cohort study. *International Journal of Cancer.* 2018;143(1):73-79. https://doi.org/10.1002/ijc.31306

5. Sherris A, Baiocchi M, Fendorf S, Luby S, Yang W, Shaw G. Nitrate in drinking water during pregnancy and spontaneous preterm birth: A retrospective within-mother analysis in California. *Environmental Health Perspectives.* 2021;129(5):057001. https://doi.org/10.1289/EHP8205

6. Stayner LT, Jensen AS, Schullehner J, Coffman VR, Trabjerg BB, Olsen J *et al.* Nitrate in drinking water and risk of birth defects: Findings from a cohort study of over one million births in Denmark. *The Lancet Regional Health – Europe.* 2022. https://doi.org/10.1016/j.lanepe.2021.100286

7. United Nations General Assembly. *Resolution 64/292: The human right to water and sanitation.* Geneva (CHE): United Nations;2010. Accessed 17 Feb 2021. https://www.un.org/ga/search/view_doc.asp?symbol=A/RES/64/292.

8. United Nations General Assembly. *Transforming our world: The 2030 agenda for sustainable development.* Geneva (CHE): United Nations;2015. Accessed 15 Mar 2021.https://sdgs.un.org/sites/default/files/publications/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf.

9. Department of Internal Affairs. *Government inquiry into Havelock North drinking water report of the Havelock North Drinking Water Inquiry: Stage 2.* Auckland (NZL)2017. Accessed 11 Feb 2020. https://www.dia.govt.nz/diawebsite.nsf/Files/Report-Havelock-North-Water-Inquiry-Stage-2/$file/Report-Havelock-North-Water-Inquiry-Stage-2.pdf.

10. Te Aho L. Te Mana o te Wai: An indigenous perspective on rivers and river management. *River Research and Applications.* 2019;35(10):1615-1621. https://doi.org/10.1002/rra.3365

11. Ministry for the Environment. *National Policy Statement for Freshwater Management.* Wellington (NZL): Ministry for the Environment;2020. Accessed 2 Feb 2022. https://environment.govt.nz/publications/national-policy-statement-for- freshwater-management-2020/.

12. Water Services Act 2021. 2021. Accessed 31 Jan 2022. https://www.legislation.govt.nz/act/public/2021/0036/latest/LMS374564.html.

13. Morgenstern U, Daughney CJ. Groundwater age for identification of baseline groundwater quality and impacts of land-use intensification – The National Groundwater Monitoring Programme of New Zealand. *Journal of Hydrology.* 2012;456-457:79-93. https://doi.org/10.1016/j.jhydrol.2012.06.010

14. Ministry for the Environment & Stats NZ. *New Zealand's Environmental Reporting Series: Our freshwater 2020.* Wellington (NZL): Ministry for the Environment & Stats NZ;2020. Accessed 10 May 2021.https://environment.govt.nz/assets/Publications/Files/our-freshwater-report-2020.pdf.

15. McDowell RW, Simpson ZP, Ausseil AG, Etheridge Z, Law R. The implications of lag times between nitrate leaching losses and riverine loads for water quality policy. *Scientific Reports.* 2021;11(1):16450. https://doi.org/10.1038/s41598-021-95302-1

16. Birdling G. *Evidence in Chief of Greg Birdling for Christchurch City Council, Land and Water Regional Plan Change 7 Hearing dated 17 July 2020.* Online2020. Accessed 17 Feb 2021. https://api.ecan.govt.nz/TrimPublicAPI/documents/download/3909177.

17. Ward MH, Jones RR, Brender JD, De Kok TM, Weyer PJ, Nolan BT *et al.* Drinking water nitrate and human health: an updated review. *International Journal of Environmental Research and Public Health.* 2018;15(7):1557. https://doi.org/10.3390/ijerph15071557

18. van Breda SG, Mathijs K, Pieters HJ, Sági-Kiss V, Kuhnle GG, Georgiadis P *et al.* Replacement of nitrite in meat products by natural bioactive compounds results in reduced exposure to N-Nitroso compounds: the PHYTOME project. *Molecular nutrition & food research.* 2021;65(20):2001214.

19. Temkin A, Evans S, Manidis T, Campbell C, Naidenko OV. Exposure-based assessment and economic valuation of adverse birth outcomes and cancer risk due tonitrate in United States drinking water. *Environ Res.* 2019;176:108442. https://doi.org/10.1016/j.envres.2019.04.009

20. Chambers T, Hales S, Anglemyer A. Letter to the editor: Correction "Nitrate-nitrite exposure through drinking water and diet and risk of colorectal cancer: A systematic review and meta-analysis of observational studies". *Clinical Nutrition.* 2021;40(11):5443-5444. https://doi.org/10.1016/j.clnu.2021.09.027

21. Gurjao C, Zhong R, Haruki K, Li YY, Spurr LF, Lee-Six H *et al.* Discovery and features of an alkylating signature in colorectal cancer. *Cancer Discovery.* 2021. https://doi.org/10.1158/2159-8290.CD-20-1656

22. Gandarilla-Esparza DD, Calleros-Rincón EY, Macias HM, González-Delgado MF, Vargas GG, Sustaita JD *et al.* FOXE1 polymorphisms and chronic exposure to nitrates in drinking water cause metabolic dysfunction, thyroid abnormalities, and genotoxic damage in women. *Genetics and Molecular Biology.* 2021;44.

23. Habermeyer M, Roth A, Guth S, Diel P, Engel KH, Epe B *et al.* Nitrate and nitrite in the diet: how to assess their benefit and risk for human health. *Molecular nutrition & food research.* 2015;59(1):106-128.

24. International Agency for Research on Cancer. *Ingested nitrate and nitrite, and cyanobacterial peptide toxins.* Lyon (FRA)2010. Accessed 25 Feb 2021. https://publications.iarc.fr/_publications/media/download/2867/c9f9c85d6dd616d774bdbbe67bae77bddeb1b4de.pdf.

25. Richards J, Chambers T, Hales S, Joy MK, Radu T, Woodward A *et al.* Nitrate contamination in drinking water and colorectal cancer: exposure assessment and estimated health burden in New Zealand. *Environmental Research.* 2021;204(112322). https://doi.org/10.1016/j.envres.2021.112322

26. Schullehner J, Hansen B, Thygesen M, Pedersen CB, Sigsgaard T. Nitrate in drinking water and colorectal cancer risk: A nationwide population-based cohort study. *Int J Cancer.* 2018;143(1):73-79. https://doi.org/10.1002/ijc.31306

27. Kreleger A, Etheridge Z. *Waimakariri Land and Water Solutions Programme: Options and solutions assessment - nitrate management.* Online: Environment Canterbury;2019. Report No. R19/68. Accessed 2 Jul 2021. https://api.ecan.govt.nz/TrimPublicAPI/documents/download/3626251.

28. Cressey P, Cridge B. *Nitrate in food and water* Wellington (NZL): Institute of Environmental Science and Research;2021. Accessed 31 Aug 2021.

https://mcusercontent.com/ac7d10ed90f765f0df9b564b7/files/0d6eaae9-6e25-328b-835e-10330f48888c/CSC21025_Nitrate_in_food_and_water_FINAL_13_August_2021.pdf

29. Lin L, St Clair S, Crowther C, Dixon L, Bloomfield F, Harding J. *Nitrate contamination in drinking water and adverse reproductive outcomes: a systematic review and meta-analysis.* Auckland (NZL): Liggins Institute, University of Auckland;2021. Accessed 17 Nov 2021. https://www.auckland.ac.nz/content/dam/uoa/liggins/docs/nitrate-contamination-in-drinking-water-and-adverse-reproductive-outcomes/nitrate-contamination-in-drinking-water-and-adverse-reproductive-outcomes.pdf.

30. French Agency for Food, E. a. O. H. S. (2022). Risks associated with the consumption of nitrites and nitrates - expert opinion. Maisons-Alfort, ANSES, Santé Publique France.

31. Coffman, V. R., et al. (2022). "Prenatal exposure to nitrate from drinking water and the risk of preterm birth: A Danish nationwide cohort study." Environ Epidemiol 6(5): e223.

32. Stayner, L. T., et al. (2021). "Exposure to nitrate from drinking water and the risk of childhood cancer in Denmark." Environment International 155: 106613.

33. Ward, M. H., et al. (2018). "Drinking water nitrate and human health: An updated review." Int J Environ Res Public Health 15(7).